DOCUMENT RESUME

ED 387 957 EC 304 311

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TITLE	Family-Focussed Developmental Care and Intervention for the Very Low Birthweight Preterm Infant at High Risk for Severe Medical Complications and Developmental Disabilities. Final Report.
INSTITUTION	National Collaborative Research Inst. for Early Childhood Intervention, Boston, MA.
SPONS AGENCY	Special Education Programs (ED/OSERS), Washington, DC. Early Education Program for Children with Disabilities.
PUB DATE	31 Mar 95
CONTRACT	H024S90003
NOTE	335p.
PUB TYPE	Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)
EDRS PRICE	MF01/PC14 Plus Postage.
DESCRIPTORS	At Risk Persons; Birth Weight; *Delivery Systems; Developmental Delays; Early Childhood Education; *Early Intervention; Family Programs; Hospitalized Children; *Hospitals; Models; Neonates; *Premature Infants; Prevention; *Program Effectiveness; Special Health Problems
IDENTIFIERS	Neonatal Intensive Care Units; *Special Care Nurseries

ABSTRACT

This federally funded project was designed to achieve three goals: (1) to test the effectiveness of an individualized behaviorally based developmental approach to providing early intervention services to very low birthweight preterm infants (and their families) in the newborn intensive care unit (NICU); (2) to evaluate this approach with low-risk, never ventilated preterm infants cared for in a special care nursery (SCN); and (3) to examine the professional and organizational structures necessary to implement this care model. Four NICUs and one SCN collaborated in the project. Differences between experimental infants and controls up to age 9 months are reported for medical outcomes, neurobehavioral outcomes, and family functioning. Results strongly supported the early intervention. The analysis of organizational structures found that such an intervention model requires a process-oriented relationship-based approach. Individual sections of this final report present the project's goals and objectives, theoretical and conceptual framework, methodology, findings, impact, and future activities. Tables and figures detailing the study's findings are appended, as are instruments used in the organizational analysis. Also attached are forms used for consultation with implementation sites, forms for consultation with individual trainees, forms for site assessment and trainee self-assessment, copies of several papers resulting from the project, and copies of additional instruments. (Contains 32 references.) (DB)

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National Collaborative Research Institute for Early Childhood Intervention (NCRI-ECI)

Family-Focussed Developmental Care and Intervention for the Very Low Birthweight Preterm Infant at High Risk for Severe Medical Complications and Developmental Disabilities

FINAL REPORT

Early Education Program for Children with Disabilities
U. S. Department of Education
Grant Number: H024S90003
CFDA: 84.024S

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31 March 1995

EC304311

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II. Abstract

National Collaborative Research Institute for Early Childhood Intervention (NCRI-ECI):

Family-Focussed Developmental Care and Intervention for the Very Low Birthweight Preterm Infant at High Risk for Severe Medical Complications and Developmental Disabilities

An Early Education Program for Children with Disabilities Project

Heidelise Als, Ph.D. Director

Linda Gilkerson, Ph.D. Co-Director

The NCRI-ECI was designed to achieve three main goals namely with diverse populations to test the effectiveness of an individualized, behaviorally based in the developmental approach to care and intervention to the newborn intensive care unit (NICU) for very low birthweight preterm infants at high risk for severe medical complications and developmental disabilities and for their families, to explore for the first time the effectiveness of the approach with medically low risk, never ventilated preterm infants cared for in a special care nursery, to examine the professional and organizational structures and processes necessary to implement this model of care. Further goals included teaching, training, and dissemination of this approach to other professionals and institutions as well as product development to facilitate the dissemination of the approach. Four NICUs and one SCN collaborated in the project. These settings provide care to highly diverse populations of families and infants, spanning the full spectrum of socioeconomic and ethnic backgrounds. Two of the NICUs care for inborn infants, two for infants transported in from other facilities. The SCN population was inborn. Of the four NICUs, two — one transport and one inborn unit — utilized a primary care nursing model; the other two utilized a traditional shift assignment model.

The NICU study infants were ≤ 28 weeks gestational age, ≤1,250g birthweight, intubated in the first 3 hours and for more than 24 hours in the first 48 hours, singletons, free from genetic and congenital difficulties, and free of major uncontrolled maternal illness. Intrauterine exposure to substances of addiction was not an exclusionary criterion. The SCN population was ≤ 34 weeks gestational age at birth, ≤ 2,500g, not intubated, free of genetic or congenital abnormalities and maternal illness, including drug use during pregnancy. The experimental intervention was carried out by a specially trained care team at each of the NICUs and the SCN, consisting of a developmental professional in collaboration with a developmentally-trained nurse clinician. The team performed behavioral observations weekly and on the basis of the information gained about the infants' strengths, competencies, and vulnerabilities, the team formulated a written record with consideration for the improvement of care and the environment, and supported the caregiving staff toward utilizing the information gleaned from the infants' behavior as framework for the structuring and implementation of their care. The control group received the care in the respective NICU or SCN which was standardly available in that setting. Once consent was obtained, random assignment was the design of choice. At one of the NICUs, random

assignment failed since the nursing staff insisted on the support of the developmental team for all infants in their care. The data from this nursery will be analyzed separately. Experimental treatment effectiveness for the three random assignment NICU populations was established in all four outcome domains. In terms of medical outcome, the experimental group infants showed significant reduction in number of days receiving hyperalimentation; interval of simultaneous intravenous and enteral feeding, i.e., transition to complete enteral feeding; significant increase in daily weight gain; reduction in necrotizing enterocolitis; younger ages at discharge from the NICU; fewer days in need for intensive care; fewer days in the hospital overall; significant reduction in hospital costs; and significant improvement in weight, height, and head circumference. In terms of neurobehavioral outcome at 2 weeks after expected due date, the intervened-with infants showed significant improvement in all four neurobehavioral system scores (Autonomic, Motor, State Organization and Attentional System, as well as Self-Regulation). They simultaneously required significantly less examiner facilitation in the course of the assessment. Electrophysiological assessment of one of the samples tested at 2 weeks after expected due date showed significant improvement in terms of frontal and occipital lob functioning as well as significantly greater differentiation (decreased coherence) in these regions. Family functioning assessment showed significant reduction in overall stress, improvement in parent competence as well as in perspective on the child, and in terms of seeing the child as an active autonomous person. Proximal environmental structuring and care delivery assessed every six months in the course of the study showed significant improvement in 10 out of 11 parameters. While the healthy preterm infants from the SCN showed no significant medical outcome differences, they showed highly significant neurobehavioral improvement on 10 out of 11 measures. On 6 of them, the intervened-with preterm infants were indistinguishable from a healthy fullterm comparison group. In terms of state and attentional functioning, the intervened-with infants were more well functioning than the fullterm comparison group. Electrophysiologically, the intervened-with preterms showed a high number of frontal lobe differences, indicating better functioning than even the fullterm infants and much better functioning than the preterm control group infants. Outcome at 9 months and 24 months has been assessed and will be analyzed.

In terms of the study of the process of implementation at each site, up to 20 professionals and parents were interviewed every six months at each of the sites by the project co-director. The interviews have all been transcribed and are being analyzed for themes within discipline across site, themes within site, and evolution across time. The main results to date from the organizations structures analysis show that developmental care requires a process-oriented, relationship-based approach. Reflective process work appears to be key in moving from a task- and performance-based to such a relationship-based approach. Supportive guidance, modeling, as well as mentoring for personal and professional growth in relationship-based work appear to be critical ingredients in the successful implementation of a developmental framework to NICU and SCN care.

Products from the NCRI-ECI include an educational training model and program for site change toward developmental care implementation; various published papers in references journals as

well as chapters in professional books; a database for developmental NICU research; several new assessment instruments for environment and care assessment as well as assessment of infant organization; a book as well as a number of research and concept papers in progress; a video module and training manual for the setting up a sibling care at NICU/SCN sites; 80 presentations given by NCRI faculty in the course of the project; 1,053 newly trained NICU and SCN professionals, 205 of which were eventually certified as reliable.

III. Table of Contents

I. Title Page 1

II. Abstract 2

III. Table of Contents 5

IV. Goals and Objectives of the Project 6

V. Theoretical and Conceptual Framework for the Project 10

VI. Description of the Methods and Participants 17

VII. Methodological and Logistical Problems and their Resolution 20

VIII. Research Findings 22

IX. Project Impact 29

X. Future Activities 41

XI. Assurances 42

Literature Cited 43

LIST OF APPENDICES

Appendix A Three NICU Study Results: Tables

Appendix B Three NICU Study Results: Figures

Appendix C SCN Healthy Preterm Study: Tables and Figures

Appendix D Organizational Structures Component: Tables

Appendix E Reflective Process Work in the NICU: Instruments

Appendix F Products

IV. Goals and Objectives of the Project

The NCRI-ECI was designed to achieve three main goals namely with diverse populations to test the effectiveness of an individualized, behaviorally based in the developmental approach to care and intervention to the newborn intensive care unit (NICU) for very low birthweight preterm infants at high risk for severe medical complications and developmental disabilities and for their families, to explore for the first time the effectiveness of the approach with medically low risk, never ventilated preterm infants cared for in a special care nursery, to examine the professional and organizational structures and processes necessary to implement this model of care. Further goals included teaching, training, and dissemination of this approach to other professionals and institutions as well as product development to facilitate the dissemination of the approach.

Collaborating sites, principal investigators, co-investigators, and key project staff for each site are outlined below.

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V. Theoretical and Conceptual Framework for the Project

The formulation underlying the model of developmental care tested hypothesizes that it is feasible to estimate the expectation of the developing brain for input and to infer the developmental goals of the infant for co-regulatory support by observing the preterm infant's behavior. The question to be tested becomes whether reading and interpreting the infant's behavior as actively engaged in patching across the mismatch of expected and available opportunities for interaction, and seeking to construct an NICU environment supportive of behavioral development, puts one in a position to better meet the fetal brain's expectations and therewith to more appropriately nurture the infant.

The approach postulates that the infant's own behavior provides the best information base from which to estimate the infant's current expectations, infer what the infant appears to attempt to accomplish and what strategies the infant uses; and on the basis of this information, estimate what supports might currently be useful in furthering the infant's competencies and supporting overall neurobehavioral organization in the face of necessary medical and nursing procedures. The infant is seen as continuously and actively self constructing,[1] and the task of care as that of collaborating with the infant, keeping in mind the brain's active development, its evolved expectations for complex yet specific multisensory inputs and experiences while acknowledging that, by virtue of the transition from the intra- to extrauterine environment, various brain systems are irreversibly triggered to function and will inevitably influence brain development to be different than in the womb environment. The formulation of the observation and the design of subsequent support for a prematurely born infant is conceptually based in knowledge of fetal brain developmental; of fullterm developmental functioning as the biological blueprint inherent in the fetus' make-up, yet modified by the altered environment-fetus transaction; and of the individual-specific strategies employed by each infant anchored in the phylogenetic human envelope. This highlights the opportunity the behavior of the infant offers as a base for inference of appropriate environment and care.[2]

It has been shown that even the earliest born and most fragile of infants display reliably observable behaviors, in the form of autonomic and visceral responses such as respiration patterns, color fluctuations, spitting, gagging, hiccoughing, bowel movement strains, etc.; in the form of movement patterns, postures and tone of trunk, extremities and face, such as finger splays, arching, grimacing, etc.; and the form of levels of awakeness, referred to as states, such as sleeping, wakefulness, and aroused upset.[3,4,5] This makes possible the development and examination of an approach geared to the interpretation of such behaviors as evidence of stress experienced, and of competence and goal strivings displayed. If successful such an approach will provide a base for formal training and education in reading the infant's cues and in inferring ways to reduce observed stress, support behavioral competence and enhance success of goal strivings[6,7] and therewith, presumably, improve development.

The vocabulary of the infant has been identified thus far along the lines of the three main subsystems outlined, the autonomic system, motor system, and the state system, with special

emphasis on the attentional system's communication, with the reasoning that the infant's ongoing communication along these subsystem lines will indicate whether what is currently going on around or within the infant is supportive of the infant's own goal strivings or is taxing and demanding and, therewith, potentially stressful for the infant.[2,8] The behavioral communications in terms of each of the subsystems can be understood as involving various subchannels of communication within each system.

Simultaneously, the infant's motor-system functioning and efforts can be observed in terms of the infant's maintenance of body tone, as well as the infant's postural repertoire and movement patterns.

The infant's state organization can be observed in terms of the infant's range of states available, the robustness and modulation of the available states, and the patterns of transition from state to state.

In order to document an infant's ongoing communication, a clinically-usable methodology has been developed for the recording of detailed observation of the infant's naturalistically occurring behaviors in the Newborn Intensive Care Unit. The continuous time sampling method utilizes 2-minute time epochs as recording intervals.

It has been found useful to observe the infant for at least 20 minutes before the infant is interacted with or actively cared for, then throughout the duration of caregiving interaction, be it vital sign taking, suctioning, diaper changing, feeding, etc., and then for at least 20 minutes after the end of a caregiving interaction. Such an observation, especially if repeated on at least a weekly basis, yields much information regarding an infant's robustness and development as the infant attempts to integrate and make the best use of the care provided.[8,9,10] The observations conducted then form the basis for the caregiving suggestions and modifications in environmental structuring.

In integrating the observed behavioral communications into a descriptive narrative, the infant's environment is first described in terms of light, sound, and activity. The behavioral picture derived from the observation period preceding the active caregiving interaction is described, in its relationship to heart rate (HR), respiration rate (RR), and blood oxygen levels (SaO_2 or $TcPO_2$). Then the caregiving interaction and its effect on the infant is documented, with the specificity of behavior observed again in relation to HR, RR, and SaO_2. The infant's efforts to integrate the effects of the interaction and also the caregiver's efforts to aid the infant are described. All observations are seen in the context of biphasic functioning of approach and self-regulation efforts, and avoidance, defense, and stress behaviors in the context of environment and interaction. This formulation maintains that an infant has strategies available to maintain smooth, well regulated balance and internal synchronization of subsystems of functioning or even approach stimuli, if the environmental configuration and input is appropriate to the infant's thresholds of functioning — appropriate in complexity, intensity, and timing of input — while

the infant also has strategies and mechanisms available to move away from and avoid environmental demands or configurations which are inappropriate in complexity, intensity, and/or timing of the infant. Such behaviors can be thought of as stress behaviors. A picture emerges from such a description as to the level of support or relative intrusiveness and vigor of sensory input at which the infant moves from self-regulatory balance to stress. The description is written in a language understandable to parents as well as professionals from various disciplines, since its purpose is to educate and support the caregivers in understanding the infant's behavioral functioning and seeing the infant as an active structurer and participant in his or her own development.

The behavioral description of the infant's functioning in the course of the interaction observed and anchored in the infant's current medical and family history, is utilized as the empirical bases from which to estimate the infant's own current developmental goals. "What is the infant attempting to accomplish?" becomes the question, rather than "what has the professional caregiver planned next for the infant?"

On the basis of the infant's own goals inferred from the observed behaviors, the next step becomes to explore opportunities in terms of the environment and the delivery of care itself to be supportive of the individual infant's goal strivings, thus presumably enhancing the infant's well being, sense of competence and effectiveness, and therewith, development. Such considerations begin with the path to the infant in terms of its appropriate supportiveness and welcoming nurturance for the infant's parents and family, who, in the developmental model of care, are understood as the primary co-regulators of the infant's development; the atmosphere and ambiance of care, nurturance, and respect for infant and family in the NICU environment; the organization and layout of the infant's care space; the structuring and delivery of specific medical and nursing care procedures and of other specialty care indicated; and the overall safe guarding and assurance of a developmental perspective on care and environment provided.

In order to provide the appropriate evolutionarily prepared econiche for the fetal infant's development, the assurance of the parents well being as the infant's primary nurturers, co-regulators, and caregivers needs to be safe-guarded.

The atmosphere of care, nurturance, and respect for infant and family are an integral component of developmentally supportive care. Parents are exquisitely attuned to the emotional ambiance of the setting, in which the immature infant is living and cared for. They seek a respectful and supportive, environment, which instills a sense of trust, accountability, and reliability.

The infant's care space may be the infant's home for 3 or 4 months. The organization and layout of the infant's care space thus presents a key opportunity for support and nurturance of infant and family.

Since the infant's specialty care involves many procedures, examinations, and therapeutic interventions delivered by staff from various disciplines, structuring and delivery of such care

and procedures in a safe, guarded, developmental perspective is a further key component of appropriate developmental care. Primary care, which involves a primary nursing team as well as primary physicians, respiratory therapists, social workers, physical and/or occupational therapists, and other disciplines as indicated, provides consistency of staffing and therewith continuity in care, fostering intimate knowledge of infant and family. In such a model, parents are active members of the primary team and participate in rounds, care conferences, decision making, and care implementation.

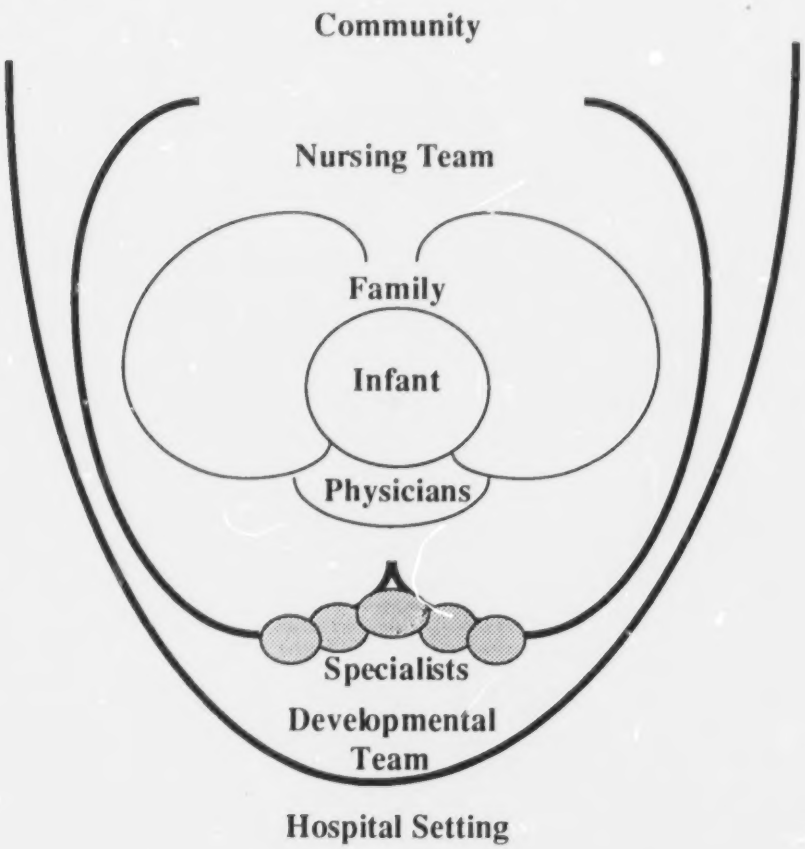


Figure 1. Developmental NICU Care Model

Figure 1 conceptualizes the developmental synactive model of care delivery, with the core focus of care on infant and family. The immediate safeguard of structuring of care is the nursing team in collaboration with the physician(s), supported by specialists, such as a respiratory, occupational, and physical therapists, social workers, etc., as indicated. The developmental team provides the ongoing catalyst for the caregivers' developmental perspective and collaboration. Qualifications for the developmental specialist include background and training in developmental and clinical pediatric or child psychology, with specialization in NICU work, in order to provide appropriate developmental support to the primary professional teams, to deliver care in an individualized and supportive manner in a developmental framework for infants and families.

The individualized developmental approach to care based on reading the preterm infant's behavioral cues as described is increasingly widely advocated[11,12,13,14,15,16,17,18] and has been tested in several studies. Als et al.[8] found improved medical outcome of very low birthweight ventilated preterm infants in terms of shorter stays on the respirator, in supplemental oxygen and on gavage feedings, improved behavioral outcome at 2 weeks corrected age as assessed with the APIB,[3,19] and at 9 months in terms of Bayley Scale Scores, and of behavioral regulation assessed in a video-taped play paradigm (Kangaroo-Box Paradigm) [20,21]. Becker et al.,[17,18,22] found significantly lower scores of morbidity in the first four weeks of hospitalization, as measured with the Minde Daily Morbidity Scale,[23] significantly earlier onset of oral feedings, better average daily weight gains, shorter hospital stays, as well as improved overall behavioral functioning at discharge, as measured with the NBAS.[24] Longterm outcome assessed for the Als study[8] at 18 months and 3 years continues to show consistently developmental advantage of the experimental group over the control group.[25] The longitudinal data available at age 7 years from this study,[26] preliminarily show much improved performance of the experimental group on a number of the neuropsychological measures.

A further study[10] has utilized random assignment of infants, weighing <1,251g, born before 30 weeks gestational age, intubated within the first 3 hours after delivery and requiring mechanical ventilation for at least 24 of the first 48 hours. Eighteen control and 20 experimental group infants met these criteria. For this study, a group of nurses were especially educated and trained in the behaviorally based approach for improvement of individualized caregiving. Staffing was structured in such a way that for the experimental group infants, at least one shift in a 24-hour cycle a specially behaviorally educated nurse cared for infant and family. Formal behavioral observations conducted by a psychologist in collaboration with a developmental clinical nurse specialist began within the first 24 hours and were repeated every tenth day until discharge from the nursery. The experimental group infants showed significant reduction in hospitalization length, age at discharge, improved weight gain to 2 weeks after due date, reduced rate of IVH, and severity of chronic lung disease, as well as reduced hospital charges. They also showed improved developmental outcome at 2 weeks corrected age, as measured with the APIB,[19] with much better functioning in terms of autonomic regulation, motor system performance, and self regulation. Systematic electrophysiological group differences by quantified EEG (qEEG) with topographic mapping[27] were also found at 2 weeks post term, implicating a large central region

of brain function difference, as well as a large occipital right hemispheric, two left parietal, a right parietal, and an additional right occipital region.

By 9 months post EDC, on assessment with the Bayley Scales of Infant Development, the experimental group compared with the control group showed a significantly higher Mental Developmental Index and Psychomotor Developmental Index.

Furthermore, of 20 infant variables measured in Play Paradigm, 17 showed differences favoring the experimental group. They ranged in significance level from $<.03$ to $<.0001$. The largest differences were found in gross and fine motor modulation, overflow postures and associated movements, complexity and modulation of combining object and social play, ability to stay engaged in the task, and degree of facilitation necessary. None of the 14 parent variables assessed showed a significant group difference, yet all three interaction variables (turn taking, overall synchrony of the interaction, and overall quality of the interaction variables; $p < .0004$) favored the experimental group. Thus, the infants in the experimental group appeared significantly more well organized, well differentiated, and well modulated than the control group infants.

VI. Description of the Methods and Participants

The NCRI-ECI involved a multi-site experimental test of the efficacy of the developmental care model when removed from the originator of the model. Participants were again high risk very low birthweight (VLBW) samples from different NICUs, as well as, for the first time, a healthy low birthweight (LBW) sample from a special care nursery (SCN). The NCRI-ECI furthermore involved the formal study of the process of implementation of the developmental care model in the various settings. Four NICUs collaborated in the project, the NICUs at Brigham and Women's Hospital, Boston, Mass. (BWH), at Children's Hospital Oakland (CHO), Children's Hospital, Boston, Mass. (CHB), and at University Medical Center, Tucson, Ariz. (TUC). The participating SCN was at the Beth Israel Hospital, Boston, Mass. (BIH). These settings provide care to highly diverse populations of families and infants, spanning the full spectrum of socioeconomic and ethnic backgrounds. Two of the NICUs care for inborn infants, two for infants transported in from other facilities. The SCN population was inborn. Of the four NICUs, two — one transport and one inborn unit — utilized a primary care nursing model; the other two utilized a traditional shift assignment model. Appendix A, Table 1 summarizes this information.

The NICU study infants were ≤ 28 weeks gestational age, ≤ 1,250g birthweight, intubated in the first 3 hours and for more than 24 hours in the first 48 hours, singletons, free from genetic and congenital difficulties, and free of major uncontrolled maternal illness. Intrauterine exposure to substances of addiction was not an exclusionary criterion. Appendix A, Table 2 summarizes the NICU sample selection criteria.

The SCN population was ≤ 34 weeks gestational age at birth, ≤2,500g, not intubated, free of genetic or congenital abnormalities and maternal illness, including drug use during pregnancy. Appendix F, Table 3 summarizes the selection criteria for the SCN sample. The experimental intervention was carried out by a specially trained care team at each of the NICUs and the SCN, consisting of a developmental professional in collaboration with a developmentally-trained nurse clinician. The team performed behavioral observations weekly and on the basis of the information gained about the infants' strengths, competencies, and vulnerabilities, the team formulated a written record with consideration for the improvement of care and the environment, and supported the caregiving staff toward utilizing the information gleaned from the infants' behavior as framework for the structuring and implementation of their care. The control group received the care in the respective NICU or SCN which was standardly available in that setting. Once consent was obtained, random assignment was the design of choice. At one of the NICUs, namely TUC, random assignment failed. Once the first experimental group infant received developmental care, the nursing staff insisted to have the support work of the developmental care team available for all infants in their care and random assignment was therefore not possible. At attempt was made to include a second nursery in Tucson as control nursery, yet within nine months of the study's beginning, this nursery hired a developmental specialist for the express purpose to provide developmental care. The NCRI TUC developmental team and site principal investigator provided training to the newly appointed developmental professional. This again precluded assessment of effectiveness of developmental care. Furthermore, the infant

populations of the two nurseries were not comparable in background characteristics, confounding assessment of intervention/effectiveness. The Tucson data therewith will be analyzed separately as longitudinal developmental data. Appendix A, Table 4 shows the number of infants eligible and successfully enrolled in the research project. A total of 237 NICU infants were eligible for the study in the three random assignment (R) NICUs (45 additional infants were eligible in the two Tucson sites); and 54 SCN infants. Of the 237 eligible R-NICU eligible study infants, 110 were successfully enrolled (of the 45 Tucson two-NICU infants, 32 infants were successfully enrolled). Of the 54 BIH SCN infants, 32 were successfully enrolled. This has for the three NICUs and the SCN, an average of close to 50% enrollment. The main reasons for non-enrollment at the Boston sites was parent refusal, since the Boston parents were asked to make a much larger time commitment for outcome assessment than was requested from the other site(s): the electrophysiological outcome study required between 6 and 8 hours for each child at each study point. The second most frequent reason for non-enrollment was staff unavailability. This was mainly an issue in Oakland, where the intervention position was shared by part-time employed professionals. Death of the infant was the third most frequent reason. Appendix A, Table 5 shows that there was no difference in the background variables between the enrolled eligible subjects and those not enrolled, assuring a bias-free study sample. Appendix A, Table 6 shows the number of children successfully enrolled who did not survive. At CHB, all children enrolled survived. By physician decision, six families (27% of non-enrolled children) were not approached for the study since the caregiving physician judged the children as not viable. Five of the six children died. This accounts for 12% of eligible children. At the BWH, 17 children (29% of the not-enrolled children) were judged by the caregiving physician as not viable; 12 of them died; yet of the 47 children successfully enrolled, 10 died (21%). At CHO, of 44 enrolled children, 8 died (18%). Table 5 indicates that more experimental group children died at the BWH. While at CHO, deaths were evenly distributed between groups. This is attributed to random sampling. Age at death did not differ between control and experimental groups, nor did it differ between the sites, as Appendix A, Table 7 shows.

When the children who died were compared to the children who survived in terms of medical background, it was found, as Appendix A, Table 8 (1 and 2) shows, that those who died were significantly different from those who survived (MANOVA Survival $F = 3.79$; $df = 9.79$; $p<.005$), and that there were differences in infant medical background between the two sites (MANOVA site $F = 2.16$; $df = 9.79$; $p < .03$). The variables which differentiated the children who died from those who survived showed that the children who died required much higher oxygen levels in the first 48 hours (Mean FIO_2), had much higher acuity of illness scores in the first 24 hours (SNAP), and required much more intensive intervention in the first 24 hours (NTISS). Thus, it appears that they were much sicker to begin with. In terms of site differences, the Oakland children had overall higher, i.e., better Apgar Scores at 5 minutes, lower, i.e., better acuity of illness scores (SNAP), somewhat lower intensive intervention scores (NTISS), yet more of them received surfactant than did the BWH children, indicating a difference in acuity and in medical treatment in favor of the Oakland children. By demographic background (Appendix A, Table 9) and by mother's medical background (Tables 10: 1 and 2), the infants who died were not different from the infants who survived. The two sites differed on various

parent medical background variables (MANOVA Site $F = 2.13$, $df = 8.80$; $p < .04$). Fewer Oakland mothers had been intrauterinely exposes to DES; fewer had received antenatal steroids; fewer were delivered by Cesarean Section; their overall Obstetric Complication Scale scores were better; yet more of them used nicotine, alcohol, and cocaine during their pregnancy. It is of interest that the 2 infants from the BWH sample who were exposed to cocaine in the womb both died; while none of the 8 Oakland infants who were exposed to cocaine in the womb died. Appendix A, Table 11 shows that onset of intervention in this study, except for the non-random assignment Tucson site, was beyond the first 24 hours. In fact, for the 2 Boston NICUs, it was on average only by Day 5; for the SCN it was on average at Day 2.5. This is considerably later than in the Als et al. (1994) study and precludes any likelihood of effectiveness for experimental reduction of intraventricular hemorrhage (IVH). The reasons for the relatively late onset of intervention was based on the complexity of consent to be obtained from attending physicians and the infants' and mothers' nurses before approaching the family for consent.

VII. Methodological and Logistical Problems and their Resolution

As pointed out above, two in some way opposing issues were encountered which had not been anticipated at the outset of the project.

1. At the Tucson site, the intervention was so well received by the nursing staff that it was impossible to maintain a control group within the same NICU. The nursing staff insisted on the support provided by the experimental intervention team — for all infants in the NICU. Since it was therefore not ethically possible to withhold this support, this made random assignment meaningless since the control condition no longer existed. In order to resolve the dilemma, a second NICU (TMC) in Tucson was approach for participation in the study, serving as control nursery. This seemed reasonable since the same medical staff who attend at the UMC NICU also attend at the TMC NICU, and the families attend the same follow-up clinic at UMC. It was hoped that the infant and family background measures would be comparable. It turned out, however, that the infants at TMC were larger and older at birth and less sick, and that the families were better off. Thus, the two populations were not comparable. Furthermore, the TMC NICU became so interested in the developmental work occurring at UMC that they approached the UMC NCRI team to train one of their nurse clinicians, with funding from the Arizona State program, to provide developmental NICU care for the TMC NICU. This invalidated the use of the study children from TMC as control group. The decision was reached that both populations will be used in a longitudinal analysis of behavioral functioning and daily morbidity scores, as well as in an analysis of newborn measures as predictors to outcome. Study children from both sites have been followed through age 2 years and some at age 3 years. The Tucson site, furthermore, fully participated in the organizational structures component of the research project, as well as in the dissemination work.

2. At the Boston sites, in contrast, resistance to implementation was very high with a new leadership team in medicine who had not participated in the original application process nor the previous research study leading to this project. The process of obtaining consent from attending physicians was complex and support was highly variable. Nursing leadership while also new to the project was overall more consistently supportive. The developmental teams' skill and stamina was certainly challenged in this situation, yet the study prevailed and the results are remarkable, given the intermittent hardships.

On the basis of the experience gained in the course of conducting the project, the investigators furthermore learned important lessons in terms of training and ongoing mentoring of developmental specialist teams. The allotted six months of start up training time is too brief for developmental specialists to be secure enough in their role. A one-year training time appears a minimum in hindsight. The second lesson highlights the difficulty for the clinically-oriented developmental specialist who also has to function as researcher. This requires additional training in research methodology and principles. A weekly supervision meeting with the developmental staff is critical and each site requires a senior psychologically-astute mentor in order to assist the developmental team in processing their work experiences. The six-monthly reflective process

meetings with the project's coordinators were invaluable. In terms of conducting research, each site should have a trained researcher on staff in order to facilitate the collaborative research project. The extensive database obtained is invaluable and no doubt unique. More staff time for data management and analysis would have been built into the project, or its scope reduced. The Oakland site had relied on its follow-up clinic for outcome data at 9 months, yet due to the national economic downturn and health care cost containment, the follow-up clinic eliminated this data point, thus precluding the possibility to obtain the 9 month data for the Oakland site. Twenty-four month data are available, although not as complete as originally anticipated. This is to point out the need for sufficient funding in order to conduct multi-site longitudinal research reliably. Overall, the project has provided an enormous opportunity for developmental care and its gradual acceptance nationwide. The data will be of tremendous support in conveying the traditionally-trained, skeptical neonatologist for whom procedurally-based care and treatment with medication are the only means to improve outcome.

In terms of the organizational structures component, the original proposal called for ethnographic interviews to assess the perceptions and acceptance of developmental care by the various disciplines at a site. It quickly became clear that a shift change in perspective is of key importance. Therefore, the organizational structures visits by the Co-Director were utilized for open-ended yet guided, clinical interviews with each of the key leadership professionals in the NICU, as well as bedside staff, parents, paraprofessionals, and the research team members. The interviews were of key therapeutic importance since they provided each participating professional with the impetus to free up an hour of undisturbed time to reflect only on him or herself, their work in the NICU, and their relationship to developmental care. The data from the interviews are partially analyzed and have yielded products as discussed below.

VIII. Research Findings

The findings will be discussed first in terms of the three-NICU study, then in terms of the SCN population one-NICU study, following which the organizational structures component findings will be discussed. In order to assess the comparability of the experimental and control groups within each site and the comparability of the infants across sites in terms of background before intervention began, multivariate analysis of variance was performed in regard to four domains of background variables: infant medical background variables, infant demographic background variables, parent demographic background variables, and parent medical background variables, shown in Appendix A, Tables 12–15. In all four domains, the control group infants were comparable to the experimental group infants, assuring that any differences in outcome between experimental and control group are not confounded by background characteristics. All four domains, however, showed significant differences between sites, indicating the diversity of the infant and parent populations cared for in the three different NICUs. In all domains, the population cared for at CHO differed from that cared for at CHB and from that cared for at the BWH. In terms of infant medical background, as Appendix A, Table 12 (2) shows (Site $F = 2.24$; $df = 20, 154$; $p < .0003$), the Oakland infants were ventilated with higher levels of oxygen in the first 10 days (mean FIO_2, first 10 days), yet their Score of Neonatal Acute Physiology (SNAP), was lower, and more of them were treated with surfactant. In terms of infant demographic background (Appendix A, Table 13) (Site $F = 1.75$; $df = 14, 160$; $p < .05$), more Oakland infants were of African-American background and fewer were Caucasian. In terms of parent demographic background (Appendix A, Table 14) (Site $F = 1.75$; $df = 14, 160$; $p < .05$), Oakland's mothers were younger, yet had more children (parity); fewer of them were married; and more of them were of the two lowest socio-economic groups. In terms of parent medical background (Appendix A, Table 15 (1 and 2) (Site $F = 1.91$; $df = 16, 158$; $p < .02$), Oakland mothers had fewer prior abortions; fewer mothers had received antenatal steroids; fewer were delivered by Cesarean Section; they had overall fewer obstetric complications, i.e., higher Obstetric Complication Scale scores, yet more Oakland mothers drank alcohol during pregnancy and only the Oakland mothers used cocaine during pregnancy (the few infants at BWH whose mothers had used cocaine did not survive; see earlier). Thus, it appears that the sites were quite diverse, yet within site, the control and experimental groups are comparable, allowing for the assessment of effectiveness of developmental care in diverse NICU populations.

Outcome was measured in terms of infant medical, neurobehavioral, and electrophysiological outcome; family outcome; as well as in terms of environment and caregiving, at 2 weeks after expected due date, and again at 9 months and 24 months after expected due date; for some children, furthermore at 36 months after expected due date. The outcome in the newborn period (2 weeks after due date) has been analyzed and will be presented. Outcome at 9 months, 24 months, and 36 months has been collected and coded, yet not yet entered and analyzed. Funds are being sought to do so.

Infant Outcome

Medical Outcome

Sixteen medical outcome variables were selected a priori on the basis of the previous studies and in an effort to describe the medical well-being of the study infants. They were subjected to multivariate analysis of variance. As Appendix A, Table 16 (1–6) indicates, the experimental group infants showed significant improvement compared to the control group infants in terms of medical outcome (Group $F = 2.02$; $df = 16, 71$; $p < .02$). The experimental group infants required fewer days of hyperalimentation, a shorter overlap period of IV and enteral feedings before complete enteral feeding; improved daily weight gain; younger ages at hospital discharge; fewer days in need of ICU care; fewer days in need of hospitalization; reduced hospital charges; lower incidence of necrotizing enterocolitis; and much improved weight, height, and head circumference at 2 weeks after expected due date (see also Appendix B, Figure 1, which graphically depicts the growth measures). Thus, the experimental group infants showed consistent improvement medically over the control group. Compared to the previous study, length of time on the respirator was not uniformly reduced, although it appeared reduced at the BWH and at CHB (see Appendix A, Table 16 (1); days in oxygen was not significantly reduced; Oakland and, to some extent, CHB appeared to show a difference, yet BWH did not show this finding. Similarly, severity of lung disease (Appendix A, Table 16 (3) found earlier to be reduced, only showed a reduction at the BWH which is in keeping with the reduction in need for the respirator found there. IVH incidence was only marginally reduced at the BWH (3 versus 7) and not at the two transport sites. It has to be kept in mind that onset of intervention at the BWH was on average at Day 5, rather than in the first 24 hours. Most IVH will have occurred by Day 3. Site differences between the sites in infant medical outcome were pronounced (Site $F = 7.16$; $df = 32, 142$; $p < .0005$) (Tables 16 (1–5) and Figure 1). Uniformly, the children at the Oakland site did overall more poorly, although the experimental effect at Oakland was large. Oakland's infants required more ventilator days than the BWH infants; more days on hyperalimentation than BWH and CHB children; more days simultaneously on IV and enteral feedings; they were older at discharge; had received many more days of ICU care and of hospitalization; and had much higher hospital costs. They overall had a much higher incidence of retinopathy of prematurity; weighed less at 2 weeks after expected due date; and had smaller head circumferences. Thus, the site differences may capture differences in treatment as well as in population.

Neurobehavioral Outcome

Neurobehavioral outcome assessed with the Assessment of Preterm Infants' Behavior (APIB)[3] showed that the experimental group infants were older than the control group at testing ($F = 4.30$; $df = 1, 86$; $p < .04$). Therefore, age at testing was used as covariate. Six systems from the APIB, when subjected to MANCOVA, showed a significant experimental effect in the hoped-for direction (Group $F = 2.90$; $df = 6, 80$; $p < .01$). All six system scores showed significant improvement for the experimental group infants: autonomic system and motor system; state

organization and attentional organization; and examiner facilitation required was significantly lower. Site differences were again highly significant (Site $F = 3.01$; $df = 12, 160$; $p < .001$), with Oakland different from the BWH and from the CHB. Of interest is that the Oakland infants were significantly more well functioning than the Boston children. This appears overall due to the big advantage of the intervened-with children.

Electrophysiological Outcome

Sixteen control group and thirteen control group infants from the BWH had complete neuroelectrophysiological studies. Nine regions of difference were identified, all in the direction of improved functioning for the intervened-with infants (Appendix A, Table 17 and Appendix B, Figure 3). The frontal and right hemispheric regions involved in the visual evoked response (VER) are reminiscent of the differences found in healthy preterms compared to fullterms.[28] In the awake state, the occipital region appears to be the most different. None of these differences were influenced by IVH, as was assessed with a path analysis. Appendix B, Figure 4 shows the results of the quantified EEG coherence analysis. Coherence, or cortical coupling, shows significant decrease for the experimental group infants, with strong frontal lobe findings and occipital (visual cortex?) findings, again right more than left, indicating much better differentiation in those areas for the intervened-with infants than the controls. There are a few connections largely central which show increased coherence for the experimental group infants. The meaning of this finding is not clear at this point. The strengths of the results of the coherence analysis is shown in Appendix A, Table 18, which indicates that a discriminant function analysis on the basis of the coherence data alone permits overall classification of the infants into control and experimental groups with 96.6% accuracy; with 100% accuracy for the experimental group children; and only one control group child misclassified. Thus, similarly to the previous study at the BWH, even in the absence of IVH as a significant influence, the electrophysiological data on the basis of qEEG are remarkably sensitive in demonstrating intervention effects, implying that the model of care tested changes brain development in the early-born infant.

Family Outcome

The four main scores from the Parenting Stress Index,[29] namely the Child Domain Score, made up of six sub-scores; the Parent Domain Score, made up of seven sub-scores; the Total Stress Score; and the Life Stress Score; as well as the Global Score from the Maternal View of the Child[30] (see Appendix A, Table 19) were subjected to a MANOVA. The experimental effect was significant in the expected direction (Group $F = 2.41$; $df = 5, 66$; $p < .05$), as Appendix A, Table 20 and Appendix B, Figure 4 show, indicating that the intervened-with parents perceived their infants as much more adaptable, acceptable, as less demanding, with more positive moods, less distractible and hypersensitive, and more reinforcing of the parent. Furthermore, the intervened-with parents portrayed themselves as less depressed, more well attached, with less role restrictions, greater sense of competence, less socially isolated, with a better relationship with their spouses, and in better health. The overall Stress Score was also significantly lower, as was the intervened-with parents' perception of life. The test "Mother's View of the Child" asks the

parent to write a brief paragraph describing the child. The parents' paragraph is then segmented into phrases which are scores on a continuum from non-differentiated concrete to interpersonally differentiated and modulated. A global score has been developed from the individual phrase scores. Thus, the family outcome measures indicate more well functioning and more well differentiated perspectives in the intervened-with families. Interestingly, there were no significant differences between sites on the family functioning measures, despite the significant socio-cultural and economic differences in background. The experimental findings are all the more assuring.

Caregiving Parameters

The three environmental variables which measure, on 5-point rating scales, light, sound, and activity in the nursery room, at large showed no significant differences across the five 6-monthly data points distributed through the study, as Appendix B, Figure 5 shows (Group $F = 0.41$; $df = 3, 78$; $p < .75$). There was a significant difference between the sites with Oakland again different, i.e., showing more light, sound, and activity than either of the two Boston sites (Site $F = 4.40$; $df = 6, 156$; $p < .0004$). However, there was also a trend toward a group by site interaction effect (G x S $F = 2.10$; $df = 6, 156$; $p < .06$). The Oakland site showed consistently improved, i.e., lower, light, sound, and activity for the experimental group infants, compared to the randomly selected controls, while it was the opposite for the BWH, where the experimental group children were cared for in brighter and louder environments. It is not clear how this is explainable. It appears that the bedside caregiving team at the BWH may have had less influence on the room conditions at large. In contrast to the lack of experimental effect for the distal caregiving parameters, all 11 proximal caregiving parameters measured showed a significant difference between control and experimental infant caregiving parameters, as Appendix B, Figure 6 (1–3) shows (Group $F = 3.39$; $df = 11, 70$; $p < .008$). Ten of the eleven parameters measured contribute to this group difference. They are more well adjusted visual arrays provided in the incubator; olfactory inputs; provision of supportive bedding and clothing; of specific self-regulatory aids; developmentally supportive positioning; developmental facilitation of feeding; burping, diapering, and bathing; supportive timing and sequencing of caregiving components; facilitation of transition between caregiving components and back to sleep; developmentally supportive state organization; developmentally supportive use of environmental inputs in support of organization of alertness; as well as developmentally supportive use of social inputs in support of organization of alertness. Thus the care that the experimental group infants received was more attuned to the individuality of each infant than was the care of randomly selected control group infants. There was again a substantial difference between sites as to the degree of developmental attunedness of care, with Oakland showing significantly less attunement of care than either of the two Boston sites (Site $F = 5.98$; $df = 27, 140$; $p < .0005$), while the Oakland experimental effect is very large. Thus, it appear that the Oakland site had comparatively less attuned developmental caregiving overall, yet showed a greater difference between experimental and control group caregiving than the two Boston sites. This may be due to the difference in primary versus conventionally scheduled nursing, the greater experience and familiarity with developmental caregiving at the Boston sites, as well as the size and complexity of the Oakland NICU compared to the two Boston units.

Developmental Care and Surfactant

Medically, the most significant advance in neonatal care has probably been the clinical introduction of surfactant, which has significantly increased survival rate of very low birthweight infants by improving their lung function. It has not yet been shown unequivocally how it affects long term outcome. In order to examine to what extent the use of surfactant contributes to the improved medical and developmental outcome found, a path analysis was performed. As Appendix A, Table 21 (1–2) shows, none of the significant medical outcomes found showed a significant indirect surfactant effect. Surfactant contributed, although not significantly, to the reduction of days on hyperalimentation, reduction in hospital charges, and improved weight and head circumference at 2 weeks after expected due date. Appendix A, Table 22 shows the path analysis results for the six APIB system scores. Surfactant has no contribution to the neurobehavioral effects found.

2. Healthy Preterm (SCN) Study

The details of the healthy preterm study can be found in Appendix C.[31] As Table 2 of the manuscript shows, there were significant background group differences between the control and experimental preterm groups on the mean daily pulmonary index for Days 1 and on the mother's obstetric complications scale score, both in the direction of favoring the control group. These two variables were used as covariates in examining outcome. None of the medical outcome variables showed any experimental effects, yet as Appendix C, Table 2 and Figure 1 shows, all six of the APIB variables show significant differences between the two preterm groups in favor of the developmentally cared-for group. After correction for multiple comparisons, the autonomic and motor system scores continue to show highly significant differences. The intervened-with preterm group is indistinguishable from the fullterm comparison group, while the preterm control group shows, prior to correction for multiple comparison, significant differences from the fullterm group on three variables, autonomic and motor system, and self-regulatory organization, all favoring the fullterm group. The same picture emerges from the additional 22 APIB measures tested and the Prechtl Neurological Examination (Appendix C, Tables 4 and 5 and Figures 2 and 3), showing the intervened-with preterm groups as largely comparable to the fullterm groups, while the biggest difference was seen between the preterm control and preterm experimental group, always in favor of the experimental group. The electrophysiological findings show 41 regions of significant difference between the three groups (Appendix C, Figure 4); of these, 18 involve the frontal lobe, 12 the temporal lobe, and 11 the central occipital and parietal regions. Of the 41 regions identified, 28 showed significant correlation with APIB behavioral measures. Thirteen of these were between the frontal lobe features and APIB variables measuring attentional control and state organization. An additional 9 features also correlated significantly with APIB measures of attention. They involved the temporary parietal and central regions. The remaining 6 correlations indicated relationship between autonomic and motor organization and control, temporal occipital and frontal function. These results suggest that differences in experience during the last trimester, when brain development is extremely active, differentially

influence the infant's neurobehavioral and neuroelectrophysiological functioning. Individualized special care provided by the preterm infant's parents in collaboration with their nursery care teams and supported by a developmental psychologist and developmentally-trained nurse appears to provide an extra-uterine environment that supports cortical development especially of the frontal lobe, which appears differentially sensitive to unexpected stimuli.

Organizational Structures Component

The Co-Director of the NCRI Project, Dr. Linda Gilkerson, visited each of the collaborating sites every six months in the course of the study for a total of five visits per site. At the BWH, CHO, and TUC NICUs, she conducted a sixth visit 6 months after data intake of the project. At each visit, she interviewed key professionals from each of the sites, as well as from the research and intervention team.

Appendix D, Tables 1 and 2, show that a total of 295 interviewers were conducted with a total of 162 separate individuals. Appendix D, Tables 3–12 identify the interview scheduled and professionals by discipline interviewed. Appendix E contains a document derived from the organizational structures work which is a helpful guide for NICUs and SCNs in better understanding the dynamics of their own setting. It assesses eight areas of a unit's functioning and considers for each of them the opportunities and challenges presenting themselves.

1. Life, vitality, and distinctive competence of a unit as a whole and the respective professional

2. Nursery complexity features in terms of site complexity, family complexity, and resources available to manage complexity

3. Primary relationships in the NICU

   a. Social identities
   b. Conflict management styles (avoidance, compromise, forcing, problem solving, referral up) between nurses and physicians; between nurses; between physicians; and for the individual developmentally engaged professional

4. Unit state

   a. Contextual variables (financial stability; staff conflict; staff changes; critical events)
   b. System balance, in terms of disequilibrium or equilibrium and transition towards equilibrium or disequilibrium
   c. Shared affect

5. Practice concerns

6. Considerations from a systems perspective

7. Support system(s) in the setting

Four tools have been developed which will assist with the training process at other NICUs, based on the reflective process work. They are presented in Appendix E and consist of a Trainee Self Assessment, as well as a Site Self Assessment, and a Trainee Evaluation and Consultation, as well as a Site Evaluation and Consultation Guide.

The preliminary results from the Organizational Structure Component indicate that the key features in implementing developmental care as a framework for newborn intensive care reside in its characteristics as theory driven, relationship based, and systems oriented. These characteristics require movement away from task and protocol orientation to a reflective process stance which utilizes ongoing thinking while acting and vice versa, as well as ongoing mindfulness and attunedness to the competencies, vulnerabilities, and goals of the child, the family, as well as the professionals engaged in caring for them. Appendix F contains the manuscript, in press, reporting on the reflective process work in the NICU.[32]

IX. Project Impact

The project's impact is felt nationally and internationally. The requests for training, as well the training successfully performed, the training centers established, as well as the now international network of NIDCAP training centers and their annual meeting are a direct product of the NCRI-ECI. An estimated total of 1,053 professionals have been trained in the NIDCAP approach in the course of the NCRI-ECI project. They span 35 states and 7 countries, including, aside from the U.S.A., Canada, Sweden, Switzerland, Italy, England, New Zealand, and Japan. Eighty lectures have been given by the NCRI investigators reaching audiences in 16 states and 10 countries. Two state-wide developmental NICU networks have been created, namely Arizona and Colorado, with a third in Illinois in emergence. Six institutions have created full-time, hospital-based developmental specialist positions for their NICUs (Central Massachusetts Medical Center, Worcester, Mass.; Children's Medical Center of Northwest Ohio and the Toledo Hospital, Toledo, Ohio; Lucile P. Packard Children's Hospital and Stanford University Medical Center, Palo Alto, Calif.; Cooper Hospital, Camden, New Jersey; St. Luke's Regional Medical Center, Boise, Idaho; Sinai Samaritan Medical Center, Milwaukee, Ill.) and the State of Arizona funds, on application, a full-time position for developmental care in each of the NICUs in the state of Arizona.

Since there are over 700 NICUs in the country, this, while an important beginning, is still only a beginning, but a promising one. An article by the Director was published as lead article in the *Journal of the American Medical Association* (1994, 272:853–58), and accompanied by a very strong editorial by the former chairman of the Perinatal Section of the American Academy of Pediatrics. This article has caught the attention of the public media, as well as of the medical professionals, hospital administrators, and health insurance companies. The NCRI data as soon as published, are expected to further the dissemination impact considerably.

Following is a list of publications which are all products of the NCRI-ECI: The list is organized by collaborative site:

Publications that have been produced by Dr. Als and her collaborators at the Boston sites:

Als, H. (1992). Individualized developmental care in the NICU: Estimating expectation for co-regulation. *Infant Behavior and Development, 15*, Special ICIS Issue, 13.

Als, H. (1992). Individualized, family-focused developmental care for the very low birthweight preterm infant in the NICU. In S.L. Friedman and M.D. Sigman (Eds.), *Advances in Applied Developmental Psychology. The Psychological Development of Low Birthweight Children. Volume 6* (pp. 341-388). Norwood, NJ: Ablex Publishing Company.

Als, H. (1994). Neurobehavioral development of the premature infant and the environment of the neonatal intensive care unit. In M.E. Avery and L. First (Eds.), *Pediatric Medicine. 2nd Edition* (pp. 155-160). Baltimore: Williams and Wilkins.

Als, H., Lawhon, G., Duffy, F.H., McAnulty, G., Gibes, R., and Blickman, J. (1994). Individualized developmental care for the very low birthweight preterm infant: Medical and neurofunctional effects. *Journal of the American Medical Association, 272*,853-858..

Buehler D.M., Als H., Duffy F.H., McAnulty G.B., Liederman J. Effectiveness of individualized developmental care for low risk preterm infants: Behavioral and electrophysiological evidence. *Pediatrics*, in press.

DeMare, D., and Mouradian, L. Supporting coregulatory developmental intervention in the NICU. *American Journal of Occupational Therapy, Special Issue: Occupational Therapy in the NICU.* Manuscript in preparation.

Duffy F.H., Als H. (1989). Brain organization in infants: Electrical activity mapping. In Paul N (ed.), *Research in Infant Assessment,* Original Article Series Vol. 25, No. 6. White Plains, NY: March of Dimes Birth Defects Foundation, 33-46.

Duffy F.H., Als H., McAnulty G.B. (1990). Behavioral and electrophysiological evidence for gestational age effects in healthy preterm and fullterm infants studied 2 weeks after expected due date. *Child Development,* 61,1271-1286.

Mouradian, L.E. and Als, H. The influence of NICU care on motor function. *American Journal of Occupational Therapy, Special Issue: Occupational Therapy in the NICU.* Submitted.

Vento, T. and and Feinberg, E. Developmentally Supportive Care. In J.P. Cloherty and A.R. Stark (Eds.), *Manual of Neonatal Care Fourth Edition.* Boston: Little, Brown and Co., in press.

The following manuscripts have been prepared and/or published by Elsa Sell, M.D. and her collaborators at the Tucson site:

Sell, E.J., Hill-Mangan, S. and Holberg, C. (1992). Natural course of early development in premature infants. *Infant Behavior and Development*, 15, 461-478.

Sell, E.J., Figueredo, A.J. and Wilcox, T.G. (1994). Assessment of preterm infants' behavior (APIB): Confirmatory factor analysis of behavioral constructs. Accepted for publication in *Infant Behavior and Development*.

Wilcox, T. and Sell, E.J. (1994). Continuity of behavioral cognitive development of healthy preterm and fullterm infants. Submitted to *Developmental Psychology*.

The Oakland site investigators have prepared and/or published the following publications:

Blackburn, S. and Vandenberg, K. (1993). Assessment and management of neurobehavioral development. In C. Kenner and L. Gunderson (Eds.), *Comprehensive Neonatal Nursing Care*. New York: W.B. Saunders.

Gale, G. Kangaroo care update: Local experts publish new findings. Accepted for publication in *Neonatal Nurses of Northern California Newsletter*, Spring 1993.

Gale, G., Franck, L. and Lund, C. kangaroo care of the intubated preterm infant. Accepted for publication in *Neonatal Network*, September 1993.

Vandenberg, K. Basic competencies to neonatal practice in NICU. Submitted by invitation to *Infants and Young Children*, accepted for publication in October 1993.

Hansen, M. and Vandnberg, K. (1993). *Homecoming for Infants Graduating from the NICU: A Guide for Parents to Infant Development After Discharge*. Austin, Texas: Pro Ed Publishing Company.

Linda Gilkerson, Ph.D. and her collaborators at the Erikson Intstiute have published the following manusripts:

GIlkerson, L. (1992). Supports for the process of change in program families. *Zero to Three*. 12(3). 19-21.

Cardone, I.A. and Gilkerson, L. (1992), Family administered Neonatal activities: an adaptatiopn for infants born with down syndrome. Infants and Young Children. 5(1), 40-48.

Gilkerson, L. and Young-Holt, E. (1992). Supervision and the management of programs serving infants, toddlers, and their families. In E. Fenichal (ed.), *Learning Through Supervision and Mentorship: a Sourcebook*. Washington: Zero to Three.

Gilkerson, L. (1994). Supporting parents in leadership roles. *Zero to Three*.14(4), 23-24.

Gilkerson, L. and Als, H. (1995) Role of reflective process in the implementation of developmentally supportive care in the neonatal intensive nursery. *Infants and Young Children*. 7, 20-28.

The following list of presentations given by NCRI staff is organized by collaborative site and represents only a portion of the actual number of presentations given:

Presentations given by Dr. Als and her collaborators at the Boston sites include:

6 October 1992	L. Mouradian	Winchester, MA	Winchester Early Intervention Program *Presentation Title:* An Introduction to Working with the Premature Infant in Early Intervention
14 October 1992	E. Feinberg	Boston, MA	Beth Israel Hospital Newborn Intensive Care Unit Staff Development Program *Presentation Title:* Experience with Kangaroo Care in the Newborn Intensive Care Nursery

21-23 October 1992	H. Als	Chicago, IL	8th Annual National Conference on Current Issues and Clinical Issues in Developmental Interventions in Neonatal Care *Presentation Titles:* *Oct. 21:* Individualized Approach to Developmental Interventions in the Newborn ICU: The Role of the Developmental Specialist *Oct. 22:* The Assessment of Preterm Infant Behavior (APIB): Theoretical Base, Training and Clinical Applications *Oct. 22:* Newborn Individualized Developmental Care and Assessment Program (NIDCAP): Definition, Training and Clinical Applications
27 October 1992	H. Als	Boston, MA	Greater Boston Chapter of the American Association of Critical Care Nurses Fall Program *Presentation Title:* Caring for the Preterm Infant: A Neurodevelopmental Perspective
28 October 1992	D. Buehler	Sturbridge, MA	Fifteenth Annual Meeting for The Massachusetts Society for Respiratory Care *Presentation Title:* The Synactive Theory of Development: An Individualized Approach to Developmental Care in the NICU
2 November 1992	D. Buehler	Falun, Sweden	Second Annual National Neonatal Nursing Conference *Presentation Title:* Family Focussed Developmental Care in the Newborn Intensive Care Setting
2 November 1992	E. Feinberg	Falun, Sweden	Second Annual National Neonatal Nursing Conference *Presentation Title:* Integration of Developmental Care Concepts into Clinical Practice
3 November 1992	D. Buehler	Falun, Sweden	Second Annual National Neonatal Nursing Conference *Panel Member:* Opportunities and Experiences Implementing Developmental Care in Newborn Intensive Care Nurseries

4 November 1992	H. Als	Belfast, Northern Ireland	The Queen's University of Belfast Parent-Child Research Group Inaugural Conference *First Northern Ireland Mother, and Baby Appeal Lecture:* The Neurobehavioural Development of the Preterm Infant: Opportunities for Care
4 November 1992	D. Buehler	Stockholm, Sweden	Cross-Disciplinary In-Service for the Karolinska Institute *Presentation Title:* The Synactive Theory of Development: An Individualized Approach to Developmental Care in the NICU
18-19 November 1992	H. Als	Washington, D.C.	Project Directors' Meeting, National Institute on Disability and Rehabilitation Research (NIDRR)
3 December 1992	H. Als	Washington, D.C.	Division for Early Childhood International Childhood Conference on Children with Special Needs *Presentation Title:* Family-Focused Developmental Care and Intervention for Very Low Birthweight Preterm Infants in the NICU
5 January 1993	H. Als	Boston, MA	Junior League of Boston Meeting *Presentation Title:* Family-Focused Care in the 90s
24-28 January 1993	H. Als	Washington, D.C.	OSEP/NEC*TAS Combined Meetings Involving State/Jurisdiction and EEPCD Project Grantees of the OSEP Early Childhood Branch *1/27/93 Presentation Title:* Materials and Learnings from the NICU Institute
3 February 1993	H. Als	San Antonio, TX	APTA Combined Sections Meetings Section on Pediatrics Pre-Conference *Presentation Title:* A Neurobehavioral Perspective on the Preterm Infant: Assessment and Opportunity for Guidance and Preventive Care
11 February 1993	H. Als	Palo Alto, CA	Stanford University Medical Center Nursing Conference *Presentation Title:* Developmentally Supportive Care in the NICU

25 February 1993	H. Als	Boston, MA	National Association of Neonatal Nurses (NANN) Clinical Update: The VLBW Infant *Keynote Presentation:* Developmental Care in the NICU: Conceptual Foundation, Implementation and Outcome
29 April 1993	D. Buehler	Norwalk, CT	Norwalk Hospital *Presentation Title:* Opportunities to Support Infant and Family Development in the NICU
8-9 June 1993	H. Als	Detroit, MI	Henry Ford Hospital High Risk Infant Conference *Presentation Titles:* Neurobehavioral Functioning of the Preterm High Risk Infant: Conceptual Considerations, Assessment of Functioning, Longitudinal Outcome, and Implications for NICU Care; Effectiveness of Individualized Developmental Care: Nurturing the Coregulation of Infant and Family in the NICU
8 July 1993	D. Buehler	Cambridge, MA	The Multidisciplinary Institute for Neuropsychological Development *Presentation Title:* Neurodevelopmentally Supportive Care for Newborns and their Families in the NICU Setting
Sept. 20, 1993	H. Als	Buenos Aires Argentina	Simposio Internacional Perinatologia La Cienda, Los Bebes Y Sus Madres *Presentation Titles:* Neurobehavioral Organization of the Preterm Infant: The Synactive Theory
Nov. 3, 1993	H. Als	Columbus, OH	Riverside Methodist Hospitals *Presentation Titles:* Introduction to NIDCAP Theory and Research Methods for Individualized Supportive Care of the Newborn and Family

Nov. 11-13, 1993	H. Als	San Francisco, CA	Contemporary Forums Developmental Interventions in Neonatal Care *Presentation Title (Nov. 11):* Data from the National Collaborative Research Institute on Family-Focused Developmental Care in the NICU: What Have We Learned? *Session Titles (Nov. 12):* *8:00 A.M.:* The Assessment of Preterm Infant Behavior (APIB): Theoretical Base, Training and Clinical Applications *10:00 A.M.:* Newborn Individualized Developmental Care and Assessment Program (NIDCAP): Definition, Education, Training and Clinical Applications
Dec. 7, 1993	H.Als	Lebanon, NH	Dartmouth-Hitchcock Medical Center The New Hampshire Perinatal Program Development of the Preterm: Assessing the Present, Maximizing the Future *Keynote Presentation:* Neurodevelopmental Perspective on the Preterm Infant: Opportunity for Care
June 2-5, 1994	H. Als	Paris, France	International Society for Infant Studies (ISIS) 8th International Conference on Infant Studies *June 3rd: Invited Symposium* Assessment of Risk in Early Infancy *Presentation Title:* Neurobehavioral Observation and Assessment of the Preterm Infant
October 7, 1994	H. Als	St. Louis, MO	The Council for Exception Children's Division of Early Childhood The Tenth Annual International Early Childhood Conference on Children with Special Needs Into the 21st Century: Creating Inclusive Communities Together, Research Symposium *Presentation Title:* Effectiveness of Individualized, Developmentally Supportive Care for VLBW Preterm Infants and their Families: Results of a Multi-Site National Study

November 10-12, 1994	H. Als	Washington, DC	Contemporary Forums Developmental Interventions in Neonatal Care *Presentation Title (Nov. 10):* The Effectiveness of Implementing Developmental Care in the Neonatal ICU *Session Titles (Nov. 11):* *0 A.M.:* The Assessment of Preterm Infants' *10:00 A.M.:* Newborn Individualized Developmental Care and Assessment Program (NIDCAP): Definition, Education, Training, and Clinical Applications
December 12-14, 1994	H. Als	Washington, DC	NEC*TAS EEPCD Projects Meeting *Presentation Title (Dec. 13):* Results from the National Collaborative Research Institute on Early Childhood Intervention (NCRI-ECI): Effectiveness of Implementing Developmental Care in the Newborn Intensive Care Unit

Presentations given by Elsa Sell, M.D. and her collaborators at the Tucson site include:

14 October 1992	S. Hill-Mangan	Baltimore, MD	Baltimore Hospital *Presentation Title:* Synactive Theory of Development as a Basis for Developmental Intervention in the NICU
22 October 1993	E. Sell	Chicago, IL	8th Annual National Conference on Current Issues and Clinical Issues in Developmental Interventions in Neonatal Care *Presentation Titles:* (1) Group Presentation on Overcoming Sources of Resistance in Providing Developmental Care to High Risk Infants in the Neonatal ICU (2) Evaluating the Implementation of an Established Program of Developmental Care in the NICU
21 January 1993	E. Sell	Tucson, AZ	Tucson Medical Center Conference on Parent and Family Needs for Maternal and Child Health Staff *Presentation Title:* Introduction on Optimal Developmental Opportunities, Family Adaptation, and Synactive Theory of Development as a Model for Integration of the Family in NICU
26 January 1993	J. McGinnis	Tucson, AZ	University Medical Center NIDCAP Workshop *Presentation Title:* Family Participation in the NICU
11 February 1993	E. Sell	Boise, ID	15th Annual Idaho Perinatal Project Conference *Presentation Title:* Family Participation in the NICU
18 February 1993	E. Sell	Tucson, AZ	Tucson Medical Center Conference on Parent and Family Needs for Maternal and Child Health Staff *Presentation Title:* Introduction on Optimal Developmental Opportunities, Family Adaptation, and Synactive Theory of Development as a Model for Integration of the Family in NICU
15 April 1994	J. McGinnis	Phoenix, AZ	Hocus Pocus Conference *Presentation Title:* Facilitating Family Support in the NICU, Using a Naturalistic Approach

12 May 1994	E. Sell	Phoenix, AZ	Neonatal Developmental Insights *Presentation Title:* Coregulatory Support for Developmental Systems Components in NICU
10 September 1994	E. Sell		Canadian Ross Conference on NICU Environment *Presentation Title:* Medical Outcomes of NIDCAP Intervention in NICU and Developmental Outcomes at Follow-up

Presentations given by the investigators at the Oakland site include:

8 October 1992	G. Gale	Oakland, CA	Oaknoll Regional Medical Center Training Program An Introduction to Neonatal Intensive Care Nursing *Presentation Title:* Developmental Issues for NICU Nurses
19 October 1992	G. Gale	Evanston, IL	Evanston Hospital *Presentation Title:* Benefits of Kangaroo Holding with Intubated Infants
21-23 October 1992	K. VandenBerg	Chicago, IL	8th Annual National Conference on Current Issues and Clinical Issues in Developmental Interventions in Neonatal Care *Presentation Titles:* (1) Establishing a Framework for Providing Developmental Care in the NICU (2) Implementing Advanced Developmental Care in the NICU (workshop conducted with Jean Cole, M.A.) (3) Developmental Care for Extremely Low Birth Weight Neonates: 24-25 Weekers
4-6 October 1992	K. VandenBerg	Atlanta, GA	Therapeutic Media, Inc. *Presentation Title:* Assessment and Intervention in the NICU and after Discharge
19 October 1992	K. VandenBerg	Oakland, CA	Kaiser Permanente Hospital *Presentation Title:* Introduction to NIDCAP: Behaviorally Supportive Care in the NICU

28 January 1993	K. VandenBerg	Stanford, CA	Lucille S. Packard Hospital The Infant with BPD *Presentation Title:* The Disorganized Feeder
17 February 1993	K. VandenBerg	Oakland, CA	Kaiser Permanente Hospital *Presentation Title:* Implementing Behaviorally Supportive Care in the NICU
25 February 1993	G. Gale	San Diego, CA	Ohmeda Critical Care Conference *Presentation Title:* Perspectives of Behaviorally Supportive Care in Two San Francisco Bay Area NICUs
30 April 1993	K. VandenBerg	Washington, DC	Annual National Conference on Issues of Infant Development *Presentation Title:* Developmental Issues After Discharge from the NICU
24-26 May 1993	K. VandenBerg	London, UK	St. Mary's Hospital *Presentation Title:* Introduction to NIDCAP Developmental Care in the NICU
20 July 1993	K. VandenBerg	Loma Linda, CA	Loma Linda University Hospital *Presentation Title:* Introduction to NIDCAP Developmental Care in the NICU
12 May 1994	K. VandenBerg	New Orleans, LA	Contemporary Forums Special Needs Annual Conference *Presentation Title:* Developmental Issues for NICU Graduates
18 May 1994	G. Gale	San Francisco, CA	National Conference on Neonatal Care *Presentation Title:* Developmentally Supportive Care and Practical Tips for Positioning the Premature Infant
27 September 1994	G. Gale	Berkeley, CA	Berkeley Marina Marriot Hotel Presentation Title: Behaviorally Supportive Neonatal Care: Test Your Knowledge

Presentations given by Linda Gilkerson, Ph D. of the Erikson Institute include:

May 1990	L. Gilkerson	Washington, DC	Association for the Care of Children's Health Annual Conference *Presentation Title:* Caring for Babies and Falmilies: The Hospital-Early Intervention Link
September 1990	L. Gilkerson	Champaign, IL	The Disabled Child XI: The Infant and Young Child Conference Carle Clinic Association and University of Illinois *Presentation Title:* Fostering Attachment Through Developmental Intervention with Infants and Their Families
December 1991	L. Gilkerson	Washington, DC	NCCIP National Traning Institute *Presentation Title:* National Collaborative Research Institute on Early Childhoos Intervention: An Examination of the Effectiveness of Family-Focussed Developmentally Oriented Neonatal Care Practices
May 1994	L. Gilkerson	Phoenix, AZ	Arizona Developmental Insights Conference *Presentation Title:* Reflections on the Implementation of Developmental Care
July 1994	L. Gilkerson	Washington, DC	Zero to Three Forum for Educators and Trainers of Infants/Family Personnel *Presentation Title:* Supervision and Mentorship: Powerful Training Tools for Infant/Family Practice

Developmental care in the NICU has become a recognized topic in early intervention and education, as well as in pediatrics and neonatology, physical, occupational, and speech and language therapy, psychology, as well as parent advocacy.

X. Future Activities

The Director and Co-Director of the NCRI are engaged in writing a book on developmental care to be published by Brookes Publisher. They are engaged in writing a joint article for *Zero to Three* and each of the investigators is engaged in the writing of various peer-reviewed journal articles. Outcome data are being evaluated and analyzed, and funding is being sought for further outcome study, a large-scale clinical trial, and a formal national education and training program in developmental care.

XI. Assurances

The full final report for NCRI-ECI has been sent to ERIC and copies of the title page and abstract/executive summary have been sent to the appropriate agencies, as outlined in the EEPCD final report guidelines.

Literature Cited

1. Fischer KW, Rose SP. Dynamic development of coordination of components in brain and behavior: A framework for theory and research. In: Dawson G, Fischer KW, ed. *Human Behavior and the Developing Brain.* New York: The Guilford Press, 1994:3-66.
2. Als H. Towards a synactive theory of development: Promise for the assessment of infant individuality. Inf Mental Health J 1982; 3:229-243.
3. Als H, Lester BM, Tronick EZ, Brazelton TB. Manual for the assessment of preterm infants' behavior (APIB). In: Fitzgerald HE, Lester BM, Yogman MW, ed. Theory and Research in Behavioral Pediatrics. 1. New York: Plenum Press, 1982:65-132.
4. Als H. Infant individuality: Assessing patterns of very early development. In: Call J, Galenson E, Tyson RL, ed. Frontiers of Infant Psychiatry. New York: Basic Books, 1983:363-378.
5. Als H. A manual for the naturalistic observation of the newborn (Preterm and Fullterm) Revision. Boston: The Children's Hospital, 1984.
6. Als H. Individualized, family-focused developmental care for the very low birthweight preterm infant in the NICU. In: Friedman SL, Sigman MD, ed. Advances in Applied Developmental Psychology. 6. Norwood, NJ: Ablex Publishing Company, 1992:341-388.
7. Als H. Newborn Individualized Developmental Care and Assessment Program (NIDCAP) Training Guide - Revised, Children's Hospital, 1995.
8. Als H, Lawhon G, Brown E, Gibes R, Duffy FH, McAnulty GB, Blickman JG. Individualized behavioral and environmental care for the very low birth weight preterm infant at high risk for bronchopulmonary dysplasia: Neonatal Intensive Care Unit and developmental outcome. Pediatrics 1986; 78:1123-1132.
9. Als H. Manual for the naturalistic observation of the newborn (preterm and fullterm), Children's Hospital, Boston, Mass., 1981.
10. Als H, Lawhon G, Duffy FH, McAnulty GB, Gibes-Grossman R, Blickman JG. Individualized developmental care for the very low birthweight preterm infant: Medical and neurofunctional effects. JAMA 1994; 272:853-858.
11. Wolke D. Environmental and developmental neonatology. J Repr Inf Psychol 1987; 5:17-42.
12. Lawhon G. Management of stress in premature infants. In: Angelini DJ, Whelan Knapp CM, Gibes RM, ed. Perinatal Neonatal Nursing: A Clinical Handbook. Boston: Blackwell Scientific Publications, 1986:319-328.
13. Lawhon G, Melzar A. Developmentally supportive interventions. In: Cloherty JP, Stark AR, ed. Manual of Neonatal Care. Boston: Little, Brown, & Co., 1991:581-584.
14. VandenBerg KA. Nippling management of the sick neonate in the NICU: The disorganized feeder. Neonatal Network 1990a; 9:9-16.
15. VandenBerg KA. Behaviorally supportive care for the extremely premature infant. In: Gunderson LP, Kenner C, ed. Care of the 24–25 Week Gestational Age Infant (Small Baby Protocol). Petaluma, Calif.: Neonatal Network, 1990b:129-157.
16. VandenBerg KA, Franck LS. Behavioral issues for infants with BPD. In: Lund C, ed. BPD: Strategies for Total Patient Care. Petaluma, Calif.: Neonatal Network, 1990:113-152.

17. Grunwald PC, Becker PT. Developmental enhancement: Implementing a program for the NICU. Neonatal Network 1990; 9:29-45.
18. Becker PT, Grunwald PC, Moorman J, Stuhr S. Effects of developmental care on behavioral organization in very-low-birth-weight infants. Nurs Res 1993; 42:214-220.
19. Als H, Lester BM, Tronick EZ, Brazelton TB. Towards a research instrument for the assessment of preterm infants' behavior. In: Fitzgerald HE, Lester BM, Yogman MW, ed. Theory and Research in Behavioral Pediatrics. 1. New York: Plenum Press, 1982:35-63.
20. Als H, Berger A. Manual and scoring system for the assessment of infants' behavior: Kangaroo-Box paradigm (unpublished manual), Boston Children's Hospital, 1986.
21. Als H, Duffy FH, McAnulty GB. Neurobehavioral competence in healthy preterm and fullterm infants: Newborn period to 9 months. Dev Psychol in press.
22. Becker PT, Grunwald PC, Moorman J, Stuhr S. Outcomes of developmentally supportive nursing care for very low birthweight infants. Nurs. Res. 1991; 40:150-155.
23. Minde K, Whitelaw A, Brown J, Fitzhardinge P. Effect of neonatal complications in premature infants on early parent-child interactions. Dev. Med. Child Neurol. 1983; 25:763-777.
24. Brazelton TB. Neonatal Behavioral Assessment Scale. Philadelphia: Spastics International Medical Publications. Lippincott, 1984.
25. Als H, Duffy FH, McAnulty GB. Longterm effects of very early individualized developmental care in the NICU to 3 and 7 years post term. in preparation.
26. Als H. Identification of behavioral disorganization in the newborn period: Opportunities for early intervention and outcome at school age. Schweiz Z Psychol Anwend in press.
27. Duffy FH, Burchfiel JL, Lombroso CT. Brain electrical activity mapping (BEAM): A method for extending the clinical utility of EEG and evoked potential data. Ann Neurol 1979; 5:309-321.
28. Duffy FH, Als H, McAnulty GB. Behavioral and electrophysiological evidence for gestational age effects in healthy preterm and fullterm infants studied 2 weeks after expected due date. Child Dev 1990; 61:1271-1286.
29. Abidin RR. Parenting Stress Index. Charlottesville, Va: 1986.
30. O'Donnell KJ. Assessment of Maternal Functioning: The Mother's View of the Child (Unpublished Manuscript). University of North Carolina at Chapel Hill, 1986.
31. Buehler DM, Als H, Duffy FH, McAnulty GB, Liederman J. Effectiveness of individualized developmental care for low risk preterm infants: Behavioral and electrophysiological evidence. Pediatrics in press.
32. Gilkerson L, Als H. Role of reflective process in the implementation of developmentally supportive care in the newborn intensive care unit. Infants and Young Children 1995; 7:20-28.

Appendix A

Three NICU Study: Tables

JPN Clinical Conference

13 March 1995, 12:00–1:00 P.M.
Children's Hospital Conference Dining Room

Developmental Care in the NICU and SCN: Preliminary Results from a Multi-Site Study

Heidelise Als, Ph.D.
Principal Investigator
Children's Hospital
tel. 355-8249

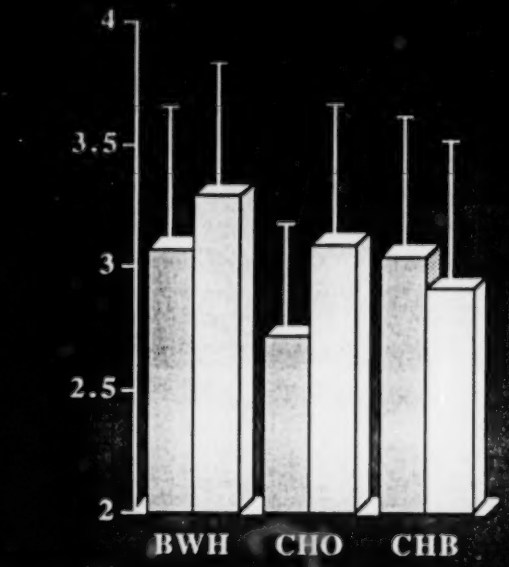
Pre-publication Data

Privileged Communication

Outcome - Medical Domain (n=92)

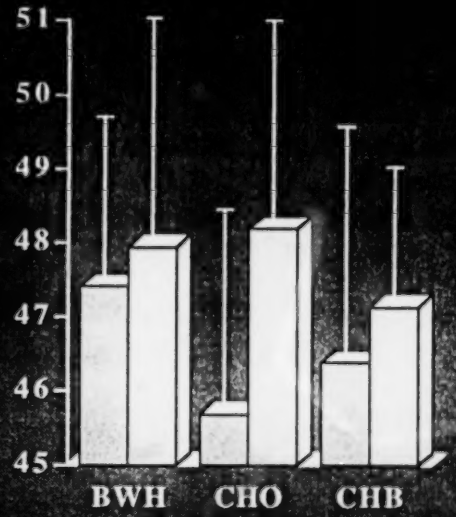
Control (BWH: n=19, CHO: n=20, CHB: n=8)
Experimental (BWH: n=18, CHO: n=16, CHB: n=11)

Weight at 42 Weeks PCA (kg)



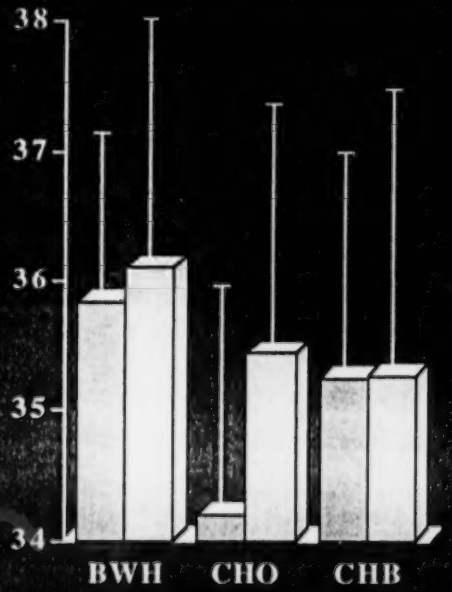
roup *r*/Site *r*: -0.37*** / 0.22**

Height at 42 Weeks PCA (cm)



-0.48*** / 0.12

Head Circumference at 42 Weeks PCA (cm)



-0.33*** / 0.29**

MANOVA:

Group:	F=2.02;	df=16,71;	p<.02
Site:	F=7.16;	df=32,142;	p<.00005
GxS:	F=1.22;	df=32.142;	p<.21

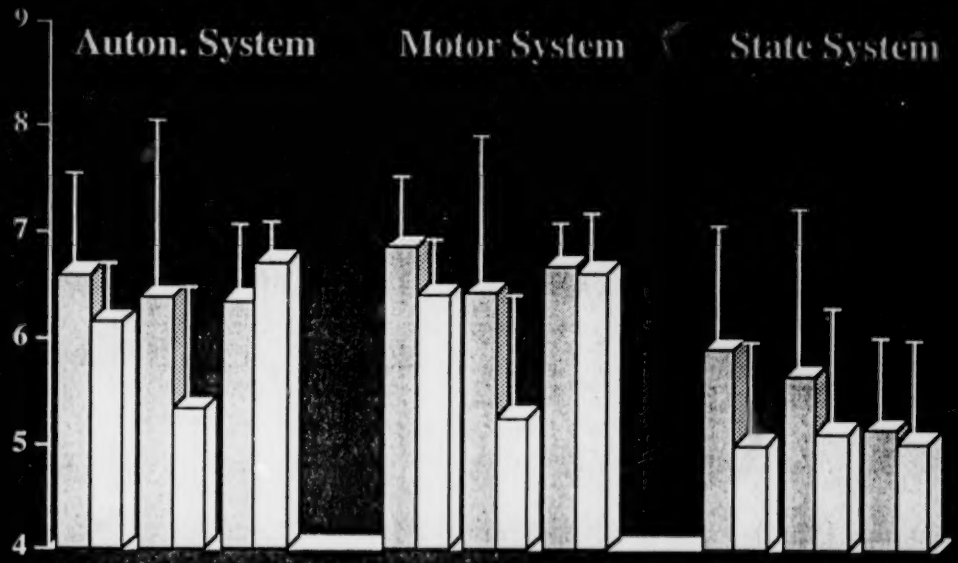
[Mahalanobis D^2 F-Matrix:

BWH vs. CHB	F=1.16;	df=16,74;	p<.30
BWH vs. CHO	F=15.35;	df=16,74;	p<.001
CHB vs. CHO	F=10.43;	df=16,74;	p<.001]

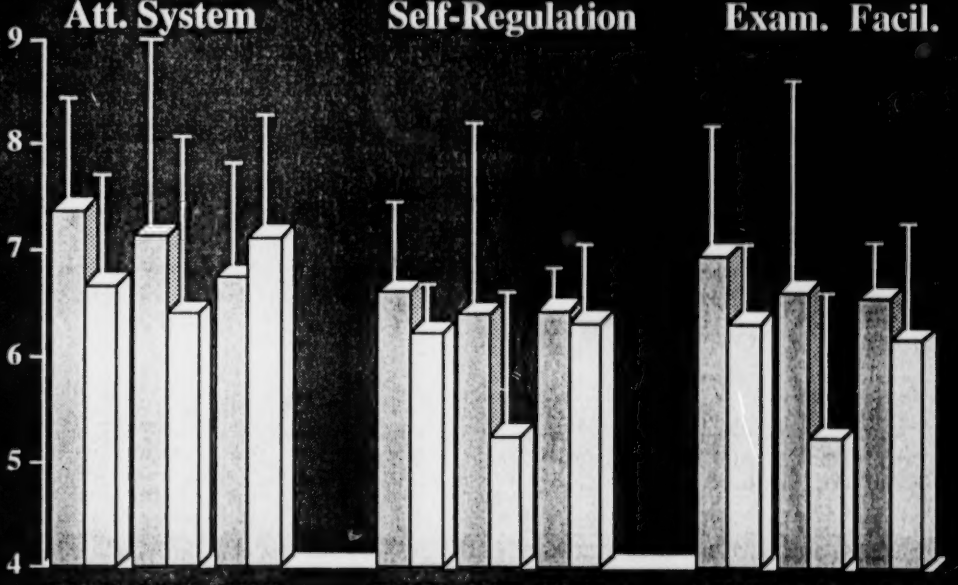
Significance Levels: * p<.05 ** p<.01 *** p<.001

Assessment of Preterm Infants' Behavior (APIB) (n=92)

Control (BWH: n=19, CHO: n=20, CHB: n=8)
Experimental (BWH: n=18, CHO: n=16, CHB: n=11)



Group *r* / Site *r*: 0.50*** / 0.48*** | 0.68*** / 0.64*** | 0.62*** / -0.13



Group *r* / Site *r*: 0.40*** / 0.12 | 0.60*** / 0.39** | 0.76*** / 0.29**

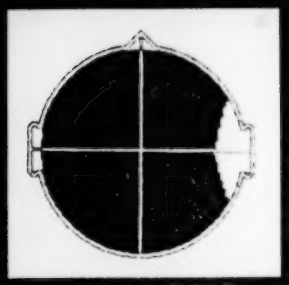
MANCOVA: Group: F=2.90; df=6,80; p<.01
Site: F=3.01; df=12,160; p<.001
GxS: F=1.38; df=12,160; p<.18
(Covariate: Age at Evaluation)

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB F=1.51; df=6,84; p<.20
BWH vs. CHO F=3.01; df=6,84; p<.05
CHB vs. CHO F=4.03; df=6,84; p<.01]

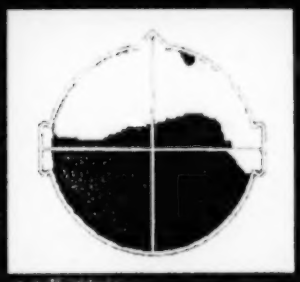
Significance Levels: * p<.05 ** p<.01 *** p<.001

qEEG Regions of Difference (BWH)

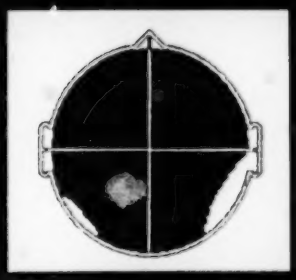
Control n=16; Experimental n=13



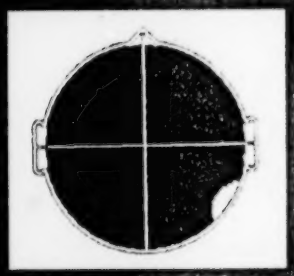
VER 64 – 84 msec
Tmax = -3.30, p≤ .003



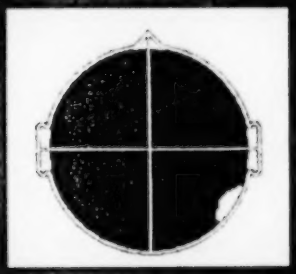
VER 144 – 164 msec
Tmax = -3.29, p≤ .003



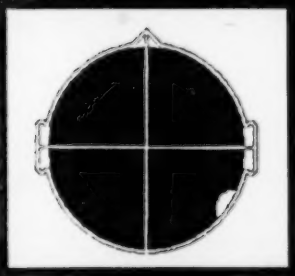
VER 592 – 612 msec
Tmax = -2.95, p≤ .007



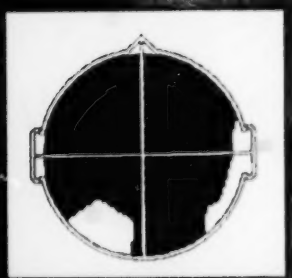
VER 1080 – 1120 msec
Tmax = -2.77, p≤ .01



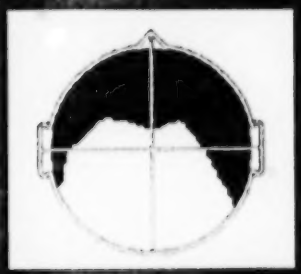
VER 1120 – 1160 msec
Tmax = -2.76, p≤ .01



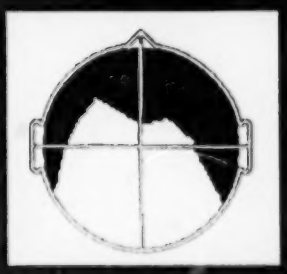
VER 1160 – 1200 msec
Tmax = -2.57, p≤ .02



Delta, Alert Processing
Tmax = 2.53, p≤ .02



Beta2, Awake Nonprocessing
Tmax = 2.92, p≤ .007

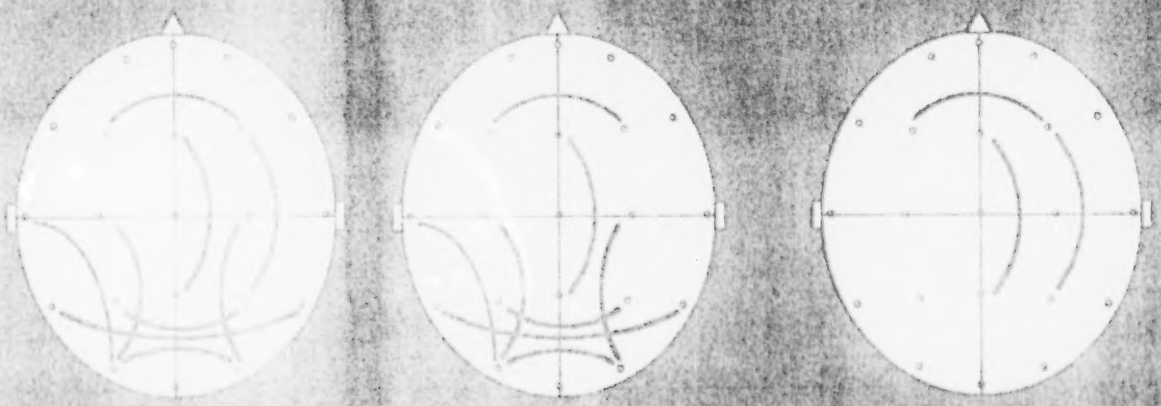


Beta3, Awake Nonprocessing
Tmax = 2.88, p≤ .008

Coherence Analysis

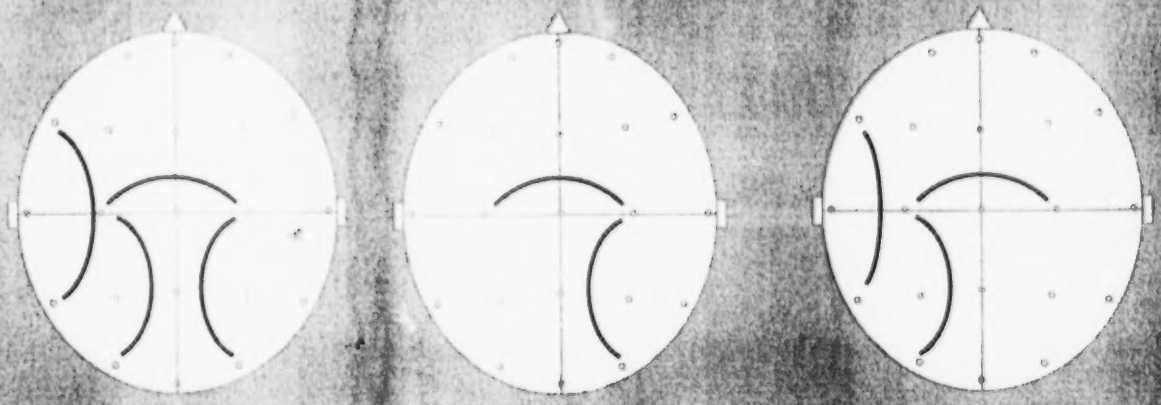
BWH: Control (13) vs. Experimental (16), 42 weeks PCA

Decreased Coherence for Experimentals



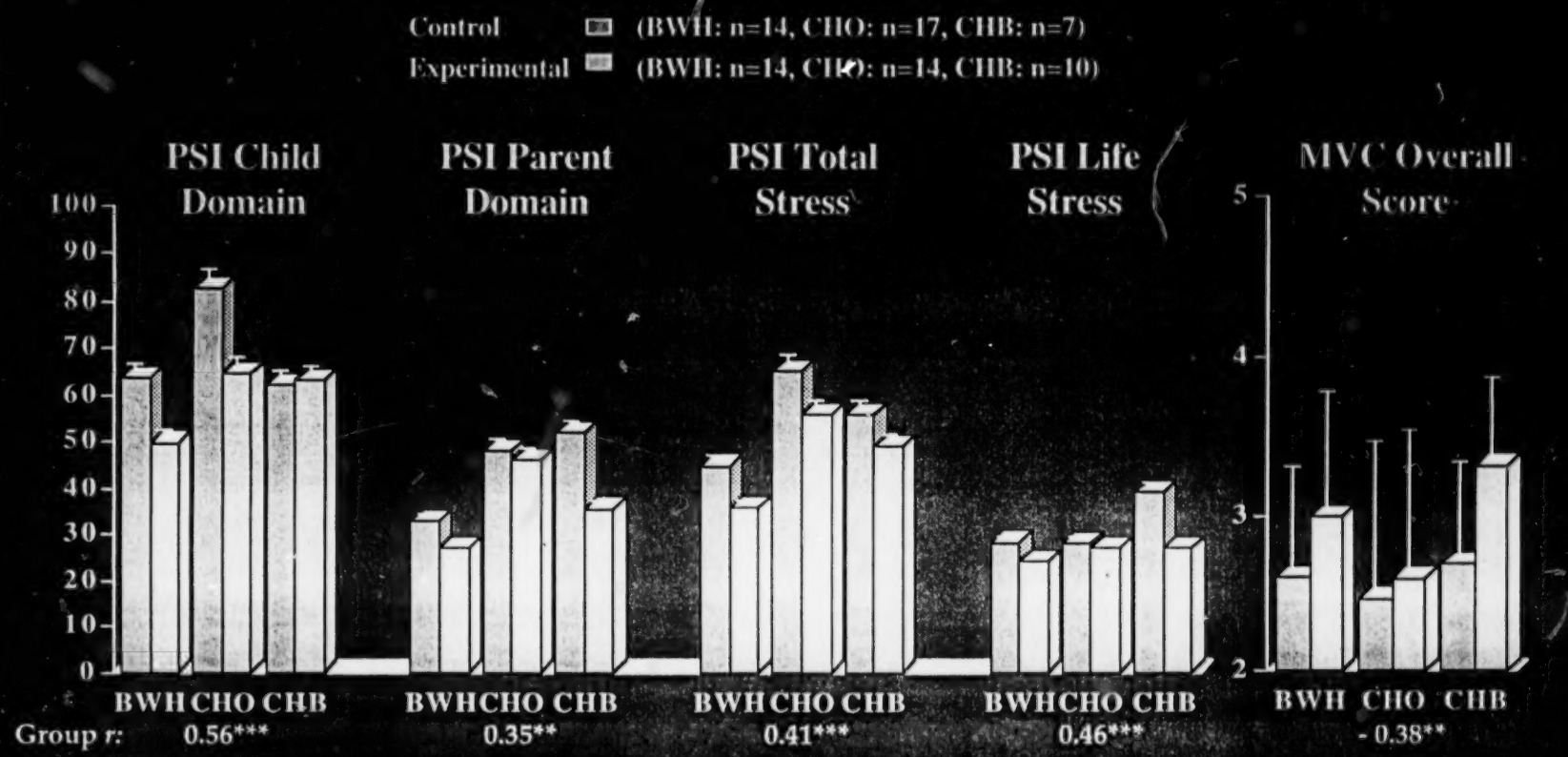
Wake & Sleep | Wake | Sleep

Increased Coherence for Experimentals



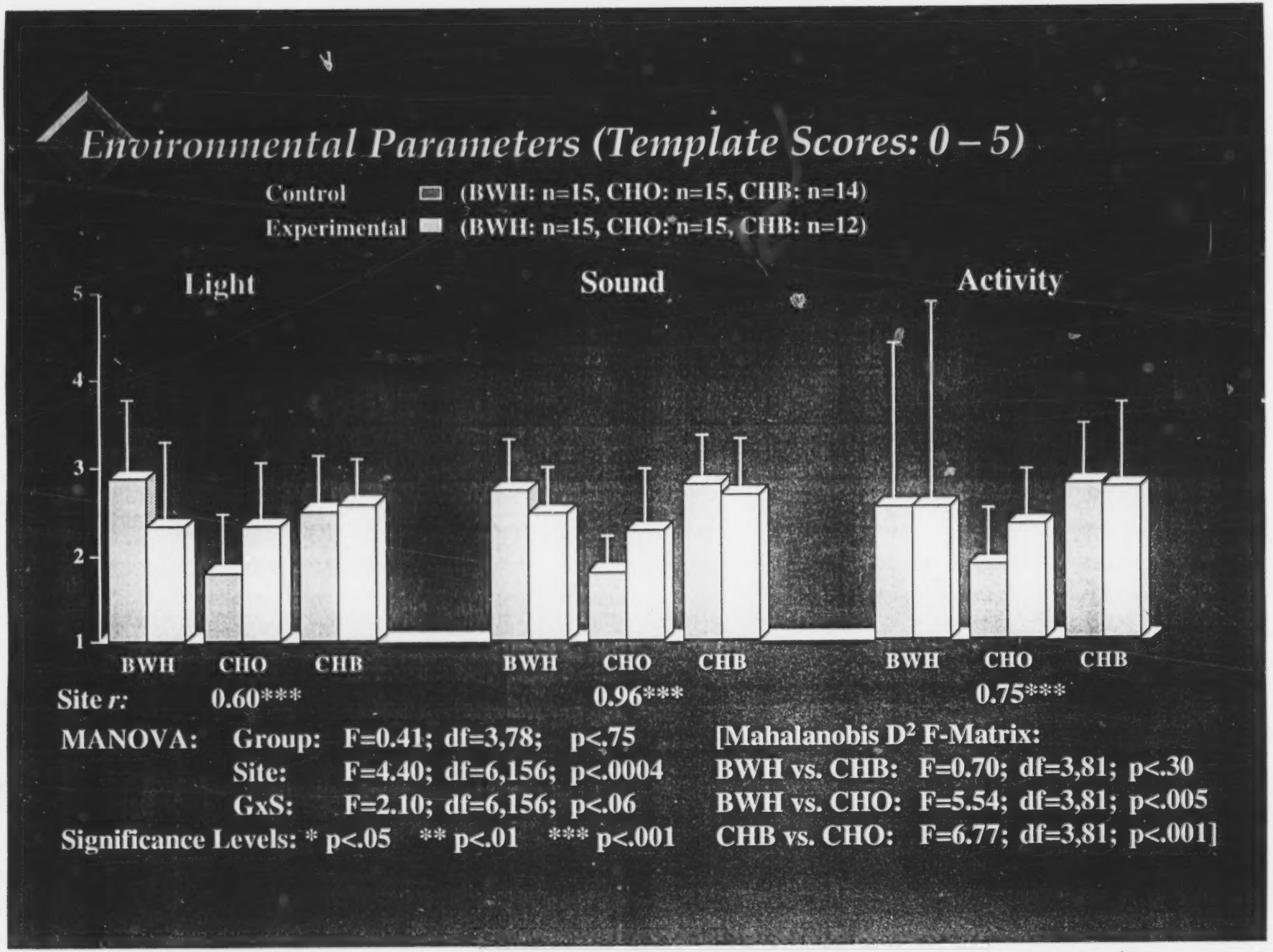
Wake & Sleep | Wake | Sleep

Outcome - Family Domain: Parenting Stress Index (PSI) and Mother's View of the Child (MVC) (n=77)



MANCOVA: Group: F=2.41; df=5,66; p<.05
Site: F=1.48; df=10,132; p<.15
GxS: F=0.57; df=10,132; p<.83

Significance Levels: * p<.05 ** p<.01 *** p<.001


Environmental Parameters (Template Scores: 0 – 5)
Control (BWH: n=15, CHO: n=15, CHB: n=14)
Experimental (BWH: n=15, CHO: n=15, CHB: n=12)
Light
Sound
Activity
5
4
3
2
1
BWH CHO CHB BWH CHO CHB BWH CHO CHB
Site r: 0.60*** 0.96*** 0.75***
MANOVA: Group: F=0.41; df=3,78; p<.75
Site: F=4.40; df=6,156; p<.0004
GxS: F=2.10; df=6,156; p<.06
Significance Levels: * p<.05 ** p<.01 *** p<.001
[Mahalanobis D² F-Matrix:
BWH vs. CHB: F=0.70; df=3,81; p<.30
BWH vs. CHO: F=5.54; df=3,81; p<.005
CHB vs. CHO: F=6.77; df=3,81; p<.001]

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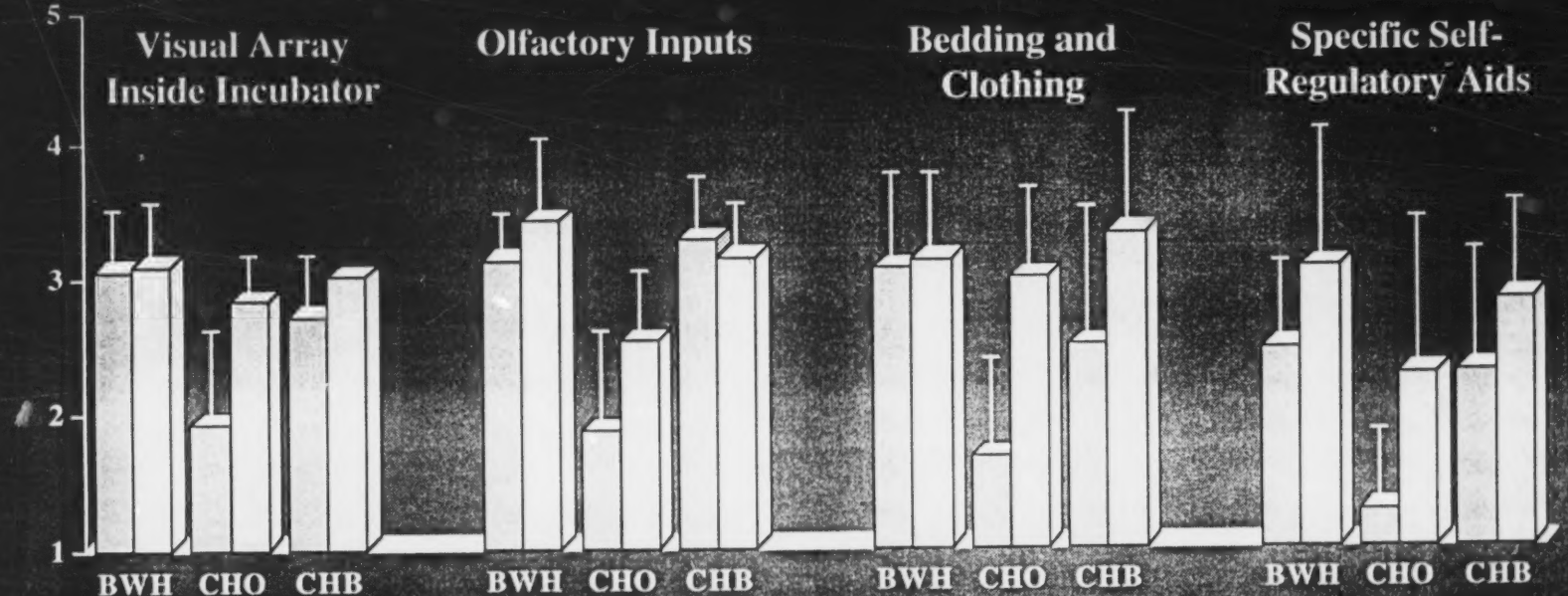
Caregiving Parameters (Template Scores: 0 – 5) (1)

Control (BWH: n=15, CHO: n=15, CHB: n=14)
Experimental (BWH: n=15, CHO: n=15, CHB: n=12)



G / S r: -0.67***/0.56*** -0.36***/0.82*** -0.76***/0.41*** -0.68***/0.51***

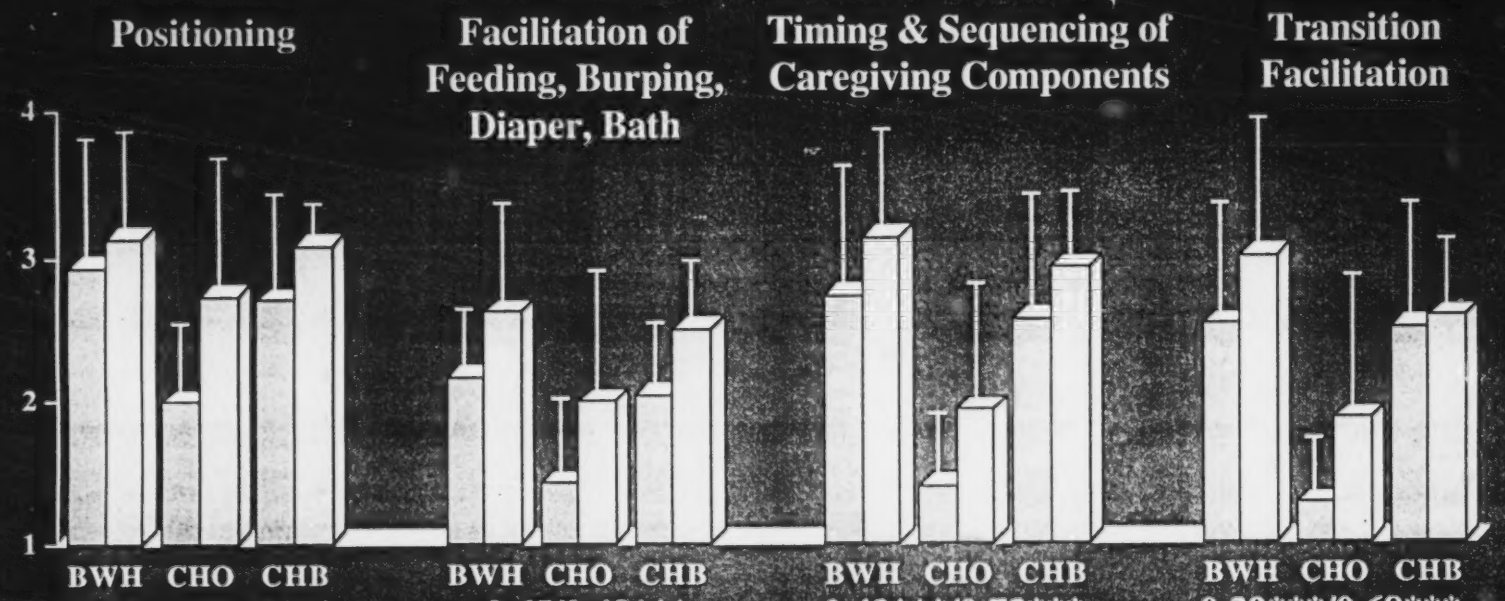
MANOVA: Group: F=3.39; df=11,70; p<.008
Site: F=5.98; df=22,140; p<.00005
GxS: F=1.35; df=22,140; p<.15
Significance Levels: * p<.05 ** p<.01 *** p<.001

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB: F=0.87; df=11,73; p<.30
BWH vs. CHO: F=9.17; df=11,73; p<.001
CHB vs. CHO: F=9.54; df=11,73; p<.001]

Caregiving Parameters (Template Scores: 0 – 5) (2)

Control (BWH: n=15, CHO: n=15, CHB: n=14)

Experimental (BWH: n=15, CHO: n=15, CHB: n=12)



G / S r: -0.52***/0.43*** -0.65/0.49*** -0.42***/0.73*** -0.39***/0.68***

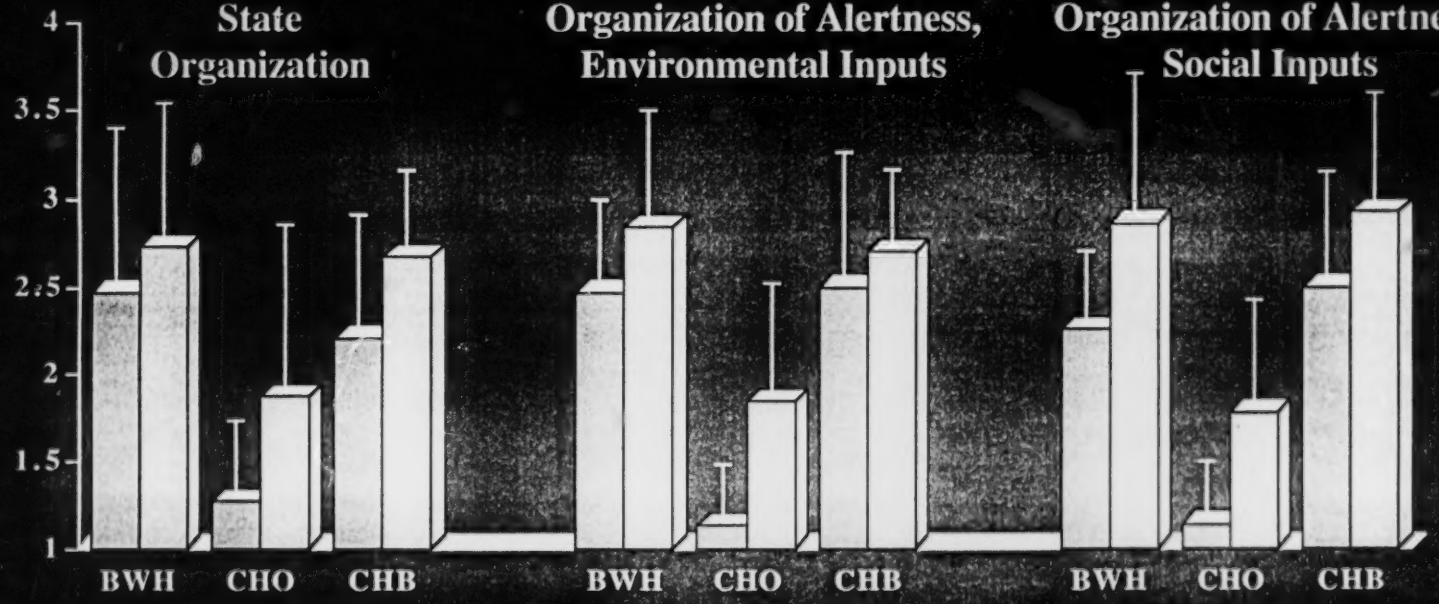
MANOVA: Group: F=3.39; df=11,70; p<.008
Site: F=5.98; df=22,140; p<.00005
GxS: F=1.35; df=22,140; p<.15

Significance Levels: * p<.05 ** p<.01 *** p<.001

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB: F=0.87; df=11,73; p<.30
BWH vs. CHO: F=9.17; df=11,73; p<.001
CHB vs. CHO: F=9.54; df=11,73; p<.001]

Caregiving Parameters (Template Scores: 0 – 5) (3)

Control (BWH: n=15, CHO: n=15, CHB: n=14)
Experimental (BWH: n=15, CHO: n=15, CHB: n=12)



G / S r: -0.46***/0.62*** -0.49***/0.82*** -0.60***/0.80***

MANOVA: Group: F=3.39; df=11,70; p<.008
Site: F=5.98; df=22,140; p<.00005
GxS: F=1.35; df=22,140; p<.15
Significance Levels: * p<.05 ** p<.01 *** p<.001

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB: F=0.87; df=11,73; p<.30
BWH vs. CHO: F=9.17; df=11,73; p<.001
CHB vs. CHO: F=9.54; df=11,73; p<.001]

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Appendix B

Three NICU Study: Figures

JPN Clinical Conference

13 March 1995, 12:00–1:00 P.M.
Children's Hospital Conference Dining Room

Developmental Care in the NICU and SCN: Preliminary Results from a Multi-Site Study

Heidelise Als, Ph.D.
Principal Investigator
Children's Hospital
tel. 355-8249

Pre-publication Data

Privileged Communication

NCRI NICU Demographics

BWH Boston:	46 Beds; Inborn, Primary Care
CH Oakland:	54 Beds; Transport; Conventional Care
CH Boston:	16 Beds; Transport; Primary Care
UMC Tucson:	32 Beds; Inborn; Conventional Care

SCN Demographics

BIH Boston:	12 Beds; Inborn; Primary Care

H. Als, NCRI-ECI, 1994

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NICU Sample Criteria

1. Birthweight ≤ 1,250 grams
2. Gestational age ≤ 28 weeks
3. Mechanical ventilation started in the first 3 hours and lasting > 24 hrs./48 hrs.
4. Living at 48 hours
5. Absence of chromosomal or major congenital anomalies (Down's, Turner's, Klinefelter's Syndromes)
6. Absence of major congenital infections (HIV, TORCH)
7. Singleton
8. Absence of major maternal illness, mental retardation, or social hardship (Note: Drug addiction not excluded)
9. Telephone access; some English language facility
10. Reasonable geographic assurance of follow-up

H. Als, NCRI-ECI, 1994

SCN Sample Criteria

1. Inborn at the BIH
2. Gestational age ≤ 34 weeks
3. Birthweight ≤ 2,500 grams
4. Absence of endotracheal intubation and ventilator support
5. Absence of chromosomal or major congenital anomalies (Down's, Turner's, Klinefelter's Syndromes)
6. Absence of major congenital infections (HIV, TORCH)
7. Singleton
8. Absence of major maternal illness, mental retardation, or social hardship (Note: Drug addiction excluded)
9. Telephone access; some English language facility
10. Reasonable geographic assurance of follow-up

H. Als, NCRI-ECI, 1994

NCRI Subject Enrollment (1 April 1990 – 1 June 1992)

	NICUs			SCN
	BWH	CHO	CHB	BIH
Total Eligible (%):	107	89	41	54
Successfully Enrolled	47 (44%)	44 (49%)	19 (46%)	32 (59%)
Control (C)	21 (45%)	24 (55%)	8 (42%)	16 (50%)
Experimental (E)	26 (55%)	20 (45%)	11 (58%)	16 (50%)
Deaths (C,E)	2,8 (10%/31%)	4,4 (17%/20%)	0,0 (0%/0%)	0,0 (0%/0%)
Living (C,E)	19,18 (90%/69%)	20,16 (83%/80%)	8,11 (100%/100%)	16,16 (100%/100%)
Not Enrolled:	60 (56%)	45 (51%)	22 (54%)	22 (41%)
Refusals	23 (38%)	4 (9%)	10 (46%)	21 (95%)
Staff Unavailable	14 (23%)	32 (71%)	4 (18%)	1 (5%)
Too Sick (MD) [Deaths]	17 [12] (29% [20%])	0 (0%)	6 [5] (27% [23%])	0 (0%)
Other (Other Study, Death, Foster Care)	2,4,0 (3%,7%,0%)	6,0,3 (13%,0%,7%)	2,0,0 (9%,0%,0%)	0 (0%)

H. Als, NCRI-ECI, 1994

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Background Characteristics of Eligible Subjects: Enrolled versus Not Enrolled

Variable Name	BWH		CHO		CHB	
	Enrolled (n = 47)	Not Enr. (n = 60)	Enrolled (n = 44)	Not Enr. (n = 45)	Enrolled (n = 19)	Not Enr. (n = 22)
Gestational Age at Birth (wks)	26.02 (1.19)	25.71 (1.44)	25.86 (1.68)	26.09 (1.59)	26.07 (1.01)	26.58 (1.23)
Birthweight (g)	0.810 (0.170)	0.803 (0.192)	0.822 (0.191)	0.864 (0.176)	0.862 (0.155)	0.855 (0.199)
Gender						
Male	24	34	24	19	12	8
Female	23	26	20	26	7	14

MANOVA:

Group: $F = 1.16; df = 3,229; p < 0.33$

Site: $F = 1.02; df = 6,458; p < 0.41$

G x S: $F = 1.58; df = 6,458; p < 0.15$

Survival Rate of Enrolled Subjects (n = 110)

	BWH		CHO		CHB	
	C (n = 21)	E (n = 26)	C (n = 24)	E (n = 20)	C (n = 8)	E (n = 11)
Alive	19	18	20	16	8	11
Deceased	2	8	4	4	0	0

Survival x Group: $\chi^2 = 2.28$; $df = 1$; $p < 0.13$
Survival x Site: $\chi^2 = 8.01$; $df = 3$; $p < 0.05$
Group x Site: $\chi^2 = 1.57$; $df = 2$; $p < 0.46$
S x g x s: $\chi^2 = 1.15$; $df = 1$; $p < 0.28$

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Age at Death (days) (n = 18)

	BWH		CHO	
	C (n = 2)	E (n = 8)	C (n = 4)	E (n = 4)
Mean	22.50	26.88	27.75	46.75
SD	6.36	20.71	20.27	29.02
Range	18.00 – 27.00	8.00 – 66.00	6.00 – 46.00	28.00 – 90.00

Group: $F^* = 1.18; df = 1,8; p < 0.31$
Site: $F^* = 1.48; df = 1,8; p < 0.26$
Group x Site $F^* = 0.71; df = 1,7; p < 0.43$

Background Characteristics of Subjects by Survival Status — Infant Medical Domain (n = 91) (1)

Variable Name	BWH Alive (n = 37)	BWH Deceased (n = 10)	CHO Alive (n = 36)	CHO Deceased (n = 8)	Survival *r*	Site *r*
Gestational Age at Birth (wks)	26.00 (1.24)	26.11 (1.03)	26.23 (1.54)	24.20 (1.26)	0.44***	0.13
Birth Weight (g)	0.806 (0.141)	0.826 (0.262)	0.845 (0.185)	0.717 (0.195)	0.19	-0.08
Birth Head Circumference (cm)	23.62 (1.48)	23.60 (1.61)	24.06 (1.96)	22.50 (2.14)	0.31**	-0.10
APGAR 1 Minute	4.00 (2.42)	3.00 (1.76)	4.08 (2.28)	2.38 (1.51)	0.43***	-0.01
APGAR 5 Minutes	6.19 (1.79)	5.60 (1.51)	6.60 (1.98)	5.88 (2.23)	0.26*	-0.26*

MANOVA: *Survival:* $F = 3.79; df = 9,79; p < .005$
Site: $F = 2.16; df = 9,79; p < .03$
S x S: $F = 1.63; df = 9,79; p < .12$

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Background Characteristics of Subjects by Survival Status — Infant Medical Domain (n = 91) (2)

Variable Name	BWH Alive (n = 37)	BWH Deceased (n = 10)	CHO Alive (n = 36)	CHO Deceased (n = 8)	Survival *r*	Site *r*
Mean FIO_2, First 48 Hours	0.42 (0.13)	0.53 (0.20)	0.38 (0.14)	0.57 (0.20)	-0.68***	-0.19
Score of Neonatal Acute Physiology (SNAP)	14.83 (4.01)	18.70 (4.37)	13.78 (6.34)	17.50 (3.59)	-0.54***	-0.27**
Neonatal Therapeutic Intervention Scoring System (NTISS)	20.65 (3.11)	25.20 (5.33)	21.97 (4.65)	24.75 (3.01)	-0.64***	-0.24*
Surfactant						
No	12	5	7	0	-0.03	-0.54***
Yes	25	5	29	8		

MANOVA: *Survival:* $F = 3.79$; $df = 9,79$; $p < .005$
Site: $F = 2.16$; $df = 9,79$; $p < .03$
S x S: $F = 1.63$; $df = 9,79$; $p < .12$

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Background Characteristics of Subjects by Survival Status — Demographic Domain (n = 91)

Variable Name	BWH Alive (n = 37)	BWH Deceased (n = 10)	CHO Alive (n = 36)	CHO Deceased (n = 8)
INFANT				
Gender				
Male	18	6	21	3
Female	19	4	15	5
Ethnicity				
Caucasian	25	7	8	4
African Am.	9	2	22	2
Other	3	1	6	2
PARENT				
Maternal Age	30.62 (6.66)	29.30 (8.82)	26.08 (7.35)	28.88 (5.36)
Parity	0.68 (0.97)	0.30 (0.68)	1.14 (1.40)	1.25 (1.67)
Marital Status				
Married/Att.	33	9	29	7
Single	4	1	7	1
Social Class				
I & II	21	4	9	0
III	6	1	8	3
IV & V	10	5	19	5

MANOVA: *Survival:* $F = 1.71$; $df = 7,81$; $p < .12$
Site: $F = 1.76$; $df = 7,81$; $p < .11$
S x S: $F = 0.60$; $df = 7,81$; $p < .75$

Background Characteristics of Subjects by Survival Status — Parent Medical Domain (n = 91) (1)

Variable Name	BWH Alive (n = 37)	BWH Deceased (n = 10)	CHO Alive (n = 36)	CHO Deceased (n = 8)	Site *r*
Exposure to DES					0.25*
No	33	9	34	8	
Yes	4	1	2	0	
Number of Prior Abortions	1.41 (1.52)	1.20 (2.25)	0.83 (1.38)	2.13 (1.73)	0.20
Antenatal Steroids					0.51***
No	16	2	20	7	
Yes	21	8	16	1	
Delivery Mode					0.62***
Vaginal	16	4	26	5	
C-Section	21	6	10	3	
Obstetric Complications	59.32 (11.16)	53.70 (5.44)	63.81 (13.85)	61.13 (13.28)	-0.47***

MANOVA: *Survival:* $F = 1.04; df = 8,80; p < .41$
Site: $F = 2.13; df = 8,80; p < .04$
S x S: $F = 2.46; df = 8,80; p < .02$

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

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Background Characteristics of Subjects by Survival Status — Parent Medical Domain (n = 91) (2)

Variable Name	BWH Alive (n = 37)	BWH Deceased (n = 10)	CHO Alive (n = 36)	CHO Deceased (n = 8)	Site *r*
Nicotine During Pregnancy					
No	31	7	26	6	-0.21*
Yes	6	3	10	2	
Alcohol During Pregnancy					
None/Minimal	34	10	27	8	-0.46***
Moderate	3	0	9	0	
Cocaine During Pregnancy					
No	37	8	28	8	-0.49***
Yes	0	2	8	0	

MANOVA: *Survival:* $F = 1.04; df = 8,80; p < .41$
Site: $F = 2.13; df = 8,80; p < .04$
S x S: $F = 2.46; df = 8,80; p < .02$

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Mean Age at First NIDCAP (hrs.)

(Alive Ss)

NICU:

BWH Boston:	**116.44**	**(56.71)**	**[4.85 days]**
CH Oakland:	**32.56**	**(24.25)**	**[1.36 days]**
CH Boston:	**120.18**	**(58.55)**	**[5.01 days]**
UMC Tucson:	**11.17**	**(7.31)**	**[0.47 days]**

SCN:

BIH Boston:	**58.75**	**(51.63)**	**[2.45 days]**

Background - Infant Medical Domain (1) (n=92)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Site *r*
Gestational Age at Birth (wks)	26.01 (1.25)	25.97 (1.27)	26.46 (1.33)	25.95 (1.77)	26.23 (1.06)	25.94 (1.01)	-0.12
Birth Weight (g)	0.814 (0.134)	0.797 (0.151)	0.877 (0.207)	0.806 (0.150)	0.915 (0.162)	0.823 (0.144)	-0.001
Birth Head Circumference (cm)	23.56 (1.57)	23.72 (1.27)	24.25 (2.22)	23.81 (1.60)	24.38 (2.07)	23.46 (1,04)	-0.13
APGAR 1 Minute	4.42 (2.36)	3.56 (2.46)	4.10 (2.20)	4.05 (2.46)	4.13 (1.73)	4.14 (2.65)	0.005
APGAR 5 Minutes	6.26 (1.94)	6.11 (1.68)	6.73 (1.97)	6.44 (2.03)	6.50 (1.20)	6.79 (1.68)	-0.04

MANOVA:
Group: $F = 0.41$; $df = 10,77$; $p < .94$
Site: $F = 2.24$; $df = 20,154$; $p < .003$
G x S: $F = 0.56$; $df = 20,154$; $p < .94$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 1.74$; $df = 10,80$; $p < .20$
BWH vs. CHO $F = 2.22$; $df = 10,80$; $p < .05$
CHB vs. CHO $F = 3.24$; $df = 10,80$; $p < .001$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

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Background - Infant Medical Domain (2) (n=92)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Site *r*
Mean FIO_2, First 48 Hours	0.45 (0.13)	0.39 (0.12)	0.39 (0.17)	0.37 (0.09)	0.39 (0.16)	0.41 (0.16)	0.13
Mean FIO_2, First 10 Days	0.36 (0.09)	0.32 (0.06)	0.36 (0.09)	0.38 (0.12)	0.31 (0.10)	0.33 (0.10)	-0.36***
Score of Neonatal Acute Physiology (SNAP)	15.61 (3.78)	14.06 (4.30)	13.00 (6.29)	14.75 (6.47)	16.88 (5.11)	17.29 (3.89)	0.41***
Neonatal Therapeutic Intervention Scoring System (NTISS)	20.75 (3.27)	20.56 (3.03)	21.95 (4.61)	22.00 (4.86)	21.91 (3.18)	23.90 (3.96)	0.07
Surfactant							
No	3	9	4	3	5	6	-0.53***
Yes	16	9	16	13	3	5	

MANOVA: Group: F = 0.41; df = 10,77; p < .94
Site: F = 2.24; df = 20,154; p < .003
G x S: F = 0.56; df = 20,154; p < .94

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB F = 1.74; df = 10,80; p < .20
BWH vs. CHO F = 2.22; df = 10,80; p < .05
CHB vs. CHO F = 3.24; df = 10,80; p < .001]

Significance Levels: * p < .05 ** p < .01 *** p < .001

Background - Infant Demographic Domain (n=92)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Site *r*
Gender							
Male	8	10	11	10	6	6	0.10
Female	11	8	9	6	2	5	
Ethnicity							
Caucasian	13	12	4	4	4	9	0.25*
African Am.	3	6	13	9	3	2	0.92***
Other	3	0	3	3	1	0	

MANOVA: Group: $F = 0.53$; $df = 7,80$; $p < .81$
Site: $F = 1.75$; $df = 14,160$; $p < .05$
G x S: $F = 0.69$; $df = 14,160$; $p < .78$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 0.22$; $df = 7,83$; $p > .20$
BWH vs. CHO $F = 3.11$; $df = 7,83$; $p < .01$
CHB vs. CHO $F = 2.08$; $df = 7,83$; $p < .05$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Background - Parent Demographic Domain (n=92)

Variable Name	BWH G (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Site *r*
Maternal Age	29.47 (6.77)	31.83 (6.52)	25.65 (7.59)	26.63 (7.25)	27.00 (5.71)	31.18 (5.60)	0.60***
Parity	0.53 (0.96)	0.83 (0.99)	1.15 (1.31)	1.13 (1.54)	0.63 (0.74)	0.55 (0.52)	-0.45***
Marital Status							
Married/Att.	17	16	15	14	7	10	-0.75***
Single	2	2	5	2	1	1	
Social Class							
I & II	10	11	5	4	4	6	-0.66***
III	2	4	4	4	2	3	
IV & V	7	3	11	8	2	2	

MANOVA: Group: $F = 0.53$; $df = 7,80$; $p < .81$
Site: $F = 1.75$; $df = 14,160$; $p < .05$
G x S: $F = 0.69$; $df = 14,160$; $p < .78$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 0.22$; $df = 7,83$; $p > .20$
BWH vs. CHO $F = 3.11$; $df = 7,83$; $p < .01$
CHB vs. CHO $F = 2.08$; $df = 7,83$; $p < .05$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

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Background - Parent Medical Domain (1) (n=92)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Site *r*
Exposure to DES							
No	17	16	18	16	8	11	0.18
Yes	2	2	2	0	0	0	
Number of Prior Abortions	0.90 (0.88)	1.94 (1.86)	0.40 (0.82)	1.38 (1.75)	1.50 (1.69)	0.18 (0.41)	0.36***
Antenatal Steroids							
No	8	8	11	9	4	6	0.23*
Yes	11	10	9	7	4	5	
Delivery Mode							
Vaginal	9	7	14	12	4	8	0.54***
C-Section	10	11	6	4	4	3	
Obstetric Complications	61.16 (11.89)	57.39 (10.33)	63.25 (12.59)	64.50 (15.69)	61.00 (9.50)	61.82 (11.76)	-0.35***

MANOVA: Group: $F = 0.22$; $df = 8,79$; $p < .95$
Site: $F = 1.91$; $df = 16,158$; $p < .02$
G x S: $F = 1.48$; $df = 16,158$; $p < .11$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 1.27$; $df = 8,82$; $p < .30$
BWH vs. CHO $F = 2.99$; $df = 8,82$; $p < .01$
CHB vs. CHO $F = 1.48$; $df = 8,82$; $p < .20$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Background - Parent Medical Domain (2) (n=92)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Site r
Nicotine During Pregnancy							
No	18	13	13	13	6	8	
Yes	1	5	7	3	2	3	
Alcohol During Pregnancy							
None/Minimal	17	17	15	12	8	9	-0.25*
Moderate	2	1	5	4	0	2	
Cocaine During Pregnancy							
No	19	18	16	12	8	11	-0.76***
Yes	0	0	4	4	0	0	

ANOVA: Group: F = 0.22; df = 8,79; p < .95
Site: E = 1.91; df = 16,158; p < .02
G X S: F = 1.48; df = 16,158; p < .11

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB F = 1.27; df = 8,82; p < .30
BWH vs. CHO F = 2.99; df = 8,82; p < .01
CHB vs. CHO F = 1.48; df = 8,82; p < .20]

Significance Levels: * p < .05 ** p < .01 *** p < .001

Outcome - Medical Domain (n = 92) (1)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Group *r*	Site *r*
Days on Respirator	34.47 (21.89)	28.67 (16.28)	43.40 (17.15)	46.63 (1.77)	50.38 (27.16)	40.55 (26.45)	0.14	-0.23*
Days on Oxygen	73.95 (61.26)	80.89 (67.73)	113.25 (110.14)	74.19 (31.99)	107.00 (99.51)	102.36 (98.93)	0.16	-0.07
Days on Hyperalimentation	20.63 (14.02)	16.39 (6.04)	41.75 (14.75)	33.25 (14.54)	27.75 (22.82)	19.91 (13.32)	0.46***	-0.59***
Days of Simultaneous IV and Enteral Feeds	10.00 (6.10)	9.67 (4.38)	25.75 (11.36)	15.94 (8.77)	25.13 (27.20)	10.73 (9.84)	0.56***	-0.40***
Average Daily Weight Gain to 42 Weeks PCA (kg)	0.019 (0.005)	0.022 (0.005)	0.017 (0.005)	0.021 (0.006)	0.019 (0.005)	0.019 (0.005)	-0.48***	0.17

MANOVA: Group: F = 2.02; df = 16,71; p < .02
Site: F = 7.16; df = 32,142; p < .0005
G x S: F = 1.22; df = 32,142; p < .21

†Mahalanobis D^2 F-Matrix:
BWH vs. CHB F = 1.16; df = 16,74; p < .30
BWH vs. CHO F = 15.35; df = 16,74; p < .001
CHB vs. CHO F = 10.43; df = 16,74; p < .001

Significance Levels: * p < .05 ** p < .01 *** p < .001

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Outcome - Medical Domain (n = 92) (2)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Group *r*	Site *r*
Postconceptional Age at Discharge (wks)	40.49 (3.08)	38.30 (2.41)	47.56 (13.99)	41.55 (4.39)	40.27 (2.44)	40.10 (2.50)	0.47***	-0.37***
Days in ICU Until Discharge	48.68 (20.14)	43.06 (15.97)	127.50 (103.94)	86.56 (28.51)	65.25 (27.23)	60.00 (27.88)	0.37***	-0.53***
Days in Hospital	101.32 (20.47)	85.94 (18.65)	148.25 (99.46)	105.44 (29.57)	101.25 (15.70)	99.73 (21.00)	0.47***	-0.34***
Hospital Charges ($)	180,814 (48,634)	156,683 (58,861)	394,824 (205,354)	314,364 (99,633)	186,865 (69,831)	203,005 (81,266)	0.34***	-0.68***

MANOVA: Group: $F = 2.02$; $df = 16,71$; $p < .02$
Site: $F = 7.16$; $df = 32,142$; $p < .0005$
G x S: $F = 1.22$; $df = 32,142$; $p < .21$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 1.16$; $df = 16,74$; $p < .30$
BWH vs. CHO $F = 15.35$; $df = 16,74$; $p < .001$
CHB vs. CHO $F = 10.43$; $df = 16,74$; $p < .001$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Outcome - Medical Domain (n = 92) (3)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Group *r*	Site *r*
Bronchopulmonary Dysplasia								
Absent	3	3	2	1	1	1	0.08	-0.009
Mild	3	2	6	4	1	2		
Moderate	7	13	7	6	3	3		
Severe	6	0	5	5	3	5		
Intraventricular Hemorrhage								
Absent	12	15	11	8	3	5	0.003	-0.008
Grade I	3	0	7	3	0	1		
Grade II	3	1	0	1	0	2		
Grade III	1	2	1	2	3	3		
Grade IV	0	0	1	2	2	0		

MANOVA:
Group: $F = 2.02$; $df = 16,71$; $p < .02$
Site: $F = 7.16$; $df = 32,142$; $p < .0005$
G x S: $F = 1.22$; $df = 32,142$; $p < .21$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 1.16$; $df = 16,74$; $p < .30$
BWH vs. CHO $F = 15.35$; $df = 16,74$; $p < .001$
CHB vs. CHO $F = 10.43$; $df = 16,74$; $p < .001$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Outcome - Medical Domain (n = 92) (4)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Group r	Site r
Necrotizing Enterocolitis							0.20*	-0.05
Absent	17	17	18	16	5	10		
Present	2	1	2	0	3	1		
Retinopathy of Prematurity							0.06	-0.30**
Absent	13	10	1	4	4	4		
Stage I	3	4	5	4	2	2		
Stage II	1	4	10	5	0	2		
Stage III	1	0	4	3	1	1		
Stage IV	0	0	0	0	0	0		
Stage V	1	0	0	0	1	2		

MANOVA: Group: $F = 2.02$; $df = 16,71$; $p < .02$
Site: $F = 7.16$; $df = 32,142$; $p < .0005$
G x S: $F = 1.22$; $df = 32,142$; $p < .21$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 1.16$; $df = 16,74$; $p < .30$
BWH vs. CHO $F = 15.35$; $df = 16,74$; $p < .001$
CHB vs. CHO $F = 10.43$; $df = 16,74$; $p < .001$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

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Outcome - Medical Domain (n = 92) (5)

Variable Name	BWH C (n = 19)	BWH E (n = 18)	CHO C (n = 20)	CHO E (n = 16)	CHB C (n = 8)	CHB E (n = 11)	Group *r*	Site *r*
Weight at 42 Weeks PCA (kg)	3.074 (0.588)	3.294 (0.544)	2.718 (0.465)	3.093 (0.576)	3.047 (0.569)	2.916 (0.604)	-0.37***	0.22*
Height at 42 Weeks PCA (cm)	47.42 (2.29)	47.94 (3.10)	45.70 (2.74)	48.19 (2.79)	46.38 (3.20)	47.14 (1.87)	-0.48***	0.12
Head Circumference at 42 Weeks PCA (cm)	35.84 (1.30)	36.11 (2.03)	34.20 (1.77)	35.44 (1.93)	35.25 (1.75)	35.27 (2.20)	-0.33***	0.29**

MANOVA: Group: $F = 2.02$; $df = 16,71$; $p < .02$
Site: $F = 7.16$; $df = 32,142$; $p < .0005$
G x S: $F = 1.22$; $df = 32,142$; $p < .21$

[Mahalanobis D^2 F-Matrix:
BWH vs. CHB $F = 1.16$; $df = 16,74$; $p < .30$
BWH vs. CHO $F = 15.35$; $df = 16,74$; $p < .001$
CHB vs. CHO $F = 10.43$; $df = 16,74$; $p < .001$]

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Outcome - qEEG (n = 29)

Variable Name	C (n = 16)	E (n = 13)	*df*	*F**	*p*
VER 64-84 msec	0.565 (0.364)	-0.011 (0.488)	1,22	12.45	0.002
VER 144-164 msec	0.608 (9.972)	-0.577 (1.070)	1,25	9.54	0.005
VER 592-612 msec	0.571 (1.911)	-1.740 (1.656)	1,27	12.15	0.002
VER 1080-1200 msec	2.230 (2.357)	-0.196 (2.525)	1,25	7.03	0.01
Delta, Alert Processing	65.031 (11.754)	80.565 (19.621)	1,19	6.31	0.02
Beta2, Awake Non-Processing	5.998 (0.877)	7.771 (2.519)	1,14	5.87	0.03
Beta3, Awake Non-Processing	4.806 (0.897)	6.752 (2.758)	1,14	5.96	0.03

Browne-Forsythe Equality of Means Test, Two-tailed: *F**
(Variances are not assumed to be equal)

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Discriminant Analysis, Coherence Data

BWH: Control (13) vs. Experimental (16), 42 weeks PCA

1) Standard Classification	Percent Correct	Control	Experimental
Control	92.3	12	1
Experimental	100.0	0	16
Total	96.6	12	17

2) Jackknife Classification	Percent Correct	Control	Experimental
Control	84.6	11	2
Experimental	93.8	1	15
Total	89.7	12	17

Outcome - Family Domain

Parenting Stress Index

Child Domain Score (47 Items)

1. Adaptability (11)
2. Acceptability (7)
3. Demandingness (9)
4. Mood (5)
5. Distractibility/ Hyperactivity(9)
6. Reinforces Parent (6)

Parent Domain Scores (54 Items)

1. Depression (9)
2. Attachment (7)
3. Restrictions of Role (7)
4. Sense of Competence (13)
5. Social Isolation (6)
6. Relationship with Spouse (7)
7. Parent Health (5)

Total Stress Score
(101 Items)

Life Stress Score
(19 Items)

Abidin, 1990

Mother's View of the Child

Overall Score (0-5)

O'Donnell et al., 1986

Outcome - Family Domain: Parenting Stress Index (PSI) and Mother's View of the Child (MVC) (n=77)

Variable Name	BWH C (n = 14)	BWH E (n = 14)	CHO C (n = 17)	CHO E (n = 14)	CHB C (n = 7)	CHB E (n = 10)	Group *r*
PSI Child Domain Score	63.57 (29.62)	49.77 (30.01)	82.52 (17.59)	64.62 (31.13)	62.13 (29.26)	63.19 (31.65)	0.56***
PSI Parent Domain Score	32.86 (33.22)	27.14 (14.75)	48.00 (29.93)	46.03 (25.17)	51.90 (19.25)	35.57 (23.09)	0.35**
PSI Total Stress Score	44.89 (34.18)	35.67 (21.26)	65.18 (27.46)	55.81 (28.82)	55.93 (22.50)	48.99 (28.55)	0.41***
PSI Life Stress Score	28.21 (9.33)	23.93 (10.95)	28.06 (14.97)	27.14 (10.51)	39.29 (15.12)	27.00 (9.19)	0.46***
MVC Overall Score	2.61 (0.70)	3.00 (0.79)	2.47 (1.01)	2.60 (0.95)	2.69 (0.65)	3.32 (0.56)	-0.38**

MANOVA:
Group: $F = 2.41$; $df = 5,66$; $p < .05$
Site: $F = 1.48$; $df = 10,132$; $p < .15$
G x S: $F = 0.57$; $df = 10,132$; $p < .83$

Significance Levels: * $p < .05$ ** $p < .01$ *** $p < .001$

Path Analysis to Medical Outcome Measures via Surfactant (n = 92) (1)

Variable Name	Direct Effect (P_{13})	Indirect Effect Surfactant ($P_{23} \times P_{12}$)	Correlation (r)
Medical Outcome Measures			
Days on mechanical ventilation	-.05	-.02	-.07
Days on oxygen	-.05	-.03	-.08
Days on hyperalimentation	-.19°	-.03	-.23*
Days on simultaneous IV and enteral feeds	-.28**	-.004	-.28**
Avg. daily weight gain to 42 weeks PCA (g)	.20*	.04	.24*
Age post LMP at discharge	-.21*	-.03	-.23*
Days in ICU	-.16°	.03	-.19°
Days in hospital	-.21*	-.02	-.23*
Hospital charges	-.14	-.03	-.17°

°$p \leq .10$ *$p \leq .05$ **$p \leq .01$

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Path Analysis to Medical Outcome Measures via Surfactant (n = 92) (2)

Variable Name	Direct Effect (P_{13})	Indirect Effect Surfactant ($P_{23} \times P_{12}$)	Correlation (r)
Medical Outcome Measures			
Bronchopulmonary Dysplasia	.04	-.04	-.004
Intraventricular Hemorrhage	.01	-.01	.00
Necrotizing Enterocolitis	-.09	-.01	.10
Retinopathy of Prematurity	-.02	-.01	.03
Weight at 42 weeks PCA (kg)	.15	.04	.19°
Height at 42 weeks PCA (cm)	.23*	.01	.24*
Head Circumference at 42 weeks PCA (cm)	.14	.03	.17°

°$p \leq .10$ *$p \leq .05$ **$p \leq .01$

Path Analysis to Behavioral Outcome Measures via Surfactant (n = 92)

Variable Name	Direct Effect (P_{13})	Indirect Effect Surfactant ($P_{23} \times P_{12}$)	Correlation (r)
Behavioral Outcome APIB			
Autonomic System	-.21*	.01	-.20*
Motoric System	-.29**	.01	-.28**
State System	-.26**	.002	-.26**
Attentional System	-.17°	.00	-.17°
Self-Regulatory System	-.25**	.00	-.25**
Examiner Facilitation Required	-.32**	.01	-.31**

°$p \leq .10$ *$p \leq .05$ **$p \leq .01$

APPENDIX C

SCN HEALTHY PRETERM STUDY: TABLES AND FIGURES

From Buehler, Als H, Duffy FH, McAnulty GB, Liederman J. "Effectiveness Of Individualized Developmental Care For Preterm Infants: Behavioral And Electrophysiological Evidence..." .Pediatrics, in press.

LIST OF TABLES

Table 1 Conventional Care versus Individualized Developmental Care: Three Examples

Table 2 Medical and Demographic Background Variables

Table 3 APIB Subsystem Variables

Table 4 APIB Summary Variables

Table 5 Prechtl Neurological Examination of the Full-term Newborn Infant

From Buehler, Als H, Duffy FH, McAnulty GB, Liederman J. "Effectivenss Of Individualized Developmental Care For Preterm Infants: Behavioral And Electrophysiological Evidence..." .Pediatics, in press.

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples

1. Bathing	Conventional Care	Individualized Developmental Care
General Goals	To provide routine infant hygiene	To provide routine infant hygiene
	To teach parent(s) bathing skill	To provide infant with opportunity for collaboration, relaxation and pleasure
		To provide parent(s) with opportunity for support of their emerging sense of competence as parent(s) when bathing their infant
Overall Nursery Environment	Bright overhead lighting	Soft, indirect lighting
	Frequent, loud sounds (e.g., voices, alarms)	Muted sounds
	Hurried staff movement	Relaxed atmosphere around bed and bath sites
	Cool room temperature	Warm temperature around bed and bath sites

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

Materials	Sponge/cloth and dish for water, or Shallow, tepid water in small basin Warming lights, positioned overhead infant's crib or incubator	Tub large enough for full body immersion Deep, warm water Soft blanket Soft cushion (e.g., foam, folded blankets) for bottom of tub Warming lights, if warranted, positioned and/or shielded for indirect, soft light Chair(s) for parent(s) or caregiver(s), comfortably positioned at height of infant's bath

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

Caregiving	Infant completely undressed If sponge bath, performed on flat mattress, infant positioned in supine If tub bath, infant carried unclothed from bed space to tub Infant washed and rinsed off, wrapped in receiving blanket, and carried back to crib or incubator Infant placed in supine, diapered, and left alone to go back to sleep	Infant gently undressed, loosely swaddled in soft blanket in softly flexed position Infant gently lowered into tub while swaddled in blanket Infant facing away from direct light Gentle, secure hands-on containment, provided for infant with transition into water Blanket slowly unswaddled when infant immersed in water to shoulder level Relaxation and enjoyment for infant when fully immersed in water Unhurried, relaxed washing of infant When indicated, infant's physical therapy activities performed while infant immersed in water Infant gently wrapped in warm blanket, diapered, clothed, and nestled into parent's or caregiver's body, returning to sleep
Results	Clean, likely exhausted infant Efficient parent(s) and caregiver	Clean, happily relaxed infant Effective parent(s) and caregiver

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

2. Gavage Feeding	Conventional Care	Individualized Developmental Care
General Goals	To provide nutritional support	To provide nutritional support To provide infant with opportunity for collaboration, relaxation, and pleasure To provide parent(s) with opportunity for support of their emerging sense of competence as parent(s) when feeding their infant
Overall Nursery Environment	Bright overhead lighting Frequent, loud sounds (e.g., voices, alarms) Hurried staff movement and clinical appearance around bed space Cool room temperature	Soft, indirect lighting Muted sounds Relaxed family atmosphere around bed space Warm temperature around bed space
Materials	Gavage supplies (syringe, feeding tube, breastmilk/formula) Mount for feeding tube fastened to incubator ceiling Mattress within incubator Blanket	Gavage supplies (syringe, feeding tube, breastmilk/formula) Comfortable recliner chair(s) with head and foot support at infant's bedsite for parent(s)/caregiver Soft blanket Breast and/or pacifier Nourishment for parents

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

Caregiving	Gavage feeding immediately following medical caregiving procedures	Infant held, wearing clean diaper and comfortable, soft bunting, semi-upright, softly tucked and nestled against parent's chest, perhaps held skin-to-skin, during and then following vital sign assessment and other medical caregiving procedures indicated before feeding
	Infant tightly swaddled and lying in prone position, arms and hands wrapped inside blanket	
	Gavage feeding tube, inserted through nose, catheter placement checked, feeding poured into syringe and syringe hung from the ceiling of the incubator, caregiver leaving bedside	Period of relaxation and perhaps social interaction preceding feeding
		Infant continuing to be held by parent while gavage tube inserted by caregiver and checked for its placement
	As syringe empties, caregiver returning to fill remains of feeding into syringe, entire feeding lasting approximately 20 minutes	Infant resting, held nestled into parent's/caregiver's body
		When infant relaxed, parent's breast, finger, or pacifier offered for nuzzling and smelling, feeding initiated, syringe perhaps held by other parent or caregiver, seated comfortably next to infant and parent, or pinned to parent/ caregiver's garment
	Caregiver using pressure to push end of feeding through tube	
	Feeding tube withdrawn	
	Infant unswaddled, turned to supine position, undressed, diapered, redressed, and again tightly swaddled, arms at infant's sides within blanket	Feeding slowly over approximately 40 minutes with opportunities for rest throughout
	Infant returned to prone position and caregiver leaves bedside	

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

		Infant held for an extended period, to foster opportunity to drift back to restful sleep
Results	Satiated, likely exhausted infant with distended stomach, restless; possibly flaccid, spitting up, decreasing oxygen saturation and heart rate instabilities Efficient caregiver with time freed up to attend to other nursery activities	Satiated, contented infant, with well regulated tone and posture, stable autonomic functioning, and smooth, calm return to restful, relaxed sleep Effective parent(s) and caregiver

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

3. Capillary Blood Drawing from Infant's Foot	Conventional Care	Individualized Developmental Care
General Goals	To provide assessment for hematocrit, blood glucose levels, electrolyte levels, and blood gas studies	To provide assessment for hematocrit, blood glucose levels, electrolyte levels, and blood gas studies To provide infant and parents with opportunity for effective coilaboration during necessary and taxing procedures
Overall Nursery Environment	Bright overhead lighting Frequent, loud sounds (e.g., voices, alarms) Hurried staff movement Cool room temperature	Soft, indirect lighting with spot light for warmth and light to infant's foot Muted sounds Relaxed atmosphere around bed site Warm temperature around bed site
Materials	Skin cleansing and lancing supplies Mattress within bed space Blanket	Skin cleansing and lancing supplies Bedding with soft, comfortable nesting (e.g., sheepskin-covered blanket rolls) Availability of parent or second caregiver Chair for parent/caregivers at height of bed space Finger or pacifier

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

Caregiving	Infant awakened in-between feeding times for blood drawing Infant turned to supine position, facing into direct light source, blanket swaddling unwrapped Infant's foot, leg and hip raised up off of blanket Infant's heel cleaned briskly and lanced, blood drawn Infant immediately repositioned to prone, covered with blanket, caregiver leaving bedside	Timing of blood drawing when infant shows arousal in sleep/wake cycle, usually clustered with other caregiving procedures and, depending on infant's energy levels, prior to feeding Infant, positioned comfortably in prone or sidelying within bed's nesting supports Infant approached quietly and with gentle and calm touch for steady containment in preparation for blood drawing procedure Gentle angling of bedding with foot end of bed lower than head end to support blood flow to infant's lower extremities Gentle unwrapping of one leg from soft blanket swaddling, foot warming Steady, calm holding of infant by parent/caregiver in softly-flexed position, offering sucking while heel area cleaned and lanced, blood gathered

TABLE 1. Conventional Care versus Individualized Developmental Care: Three Examples (continued)

		Infant's foot and leg gently contained and realigned in parent's or caregiver's hands, infant held and cuddled until calmly reorganized
Results	Blood drawn for study Infant distressed and depleted, with autonomic and motor upset, for considerable period following procedure	Blood drawn for study Infant's overall competence fostered during painful, necessary medical procedure, return to relaxation assured Parent's comfortable and competent in supporting their infant through difficult experiences

TABLE 2. Medical and Demographic Background Variables

	Group				Pairwise Comparisons		
	Preterm Control (I): n=12	Preterm Experimental (II): n=12	Fullterm Comparison (III): n=12	*p*	I&II *p*	I&III *p*	II&III *p*
Gestational Age at Birth	32.14 (1.12)	32.19 (0.86)	39.48 (0.70)	0.0001	0.91	0.0001*	0.0001*
Gender (male, female)	3 / 9	6 / 6	5 / 7	0.44	0.21	0.39	0.68
Birthweight (g)	1707.00 (424.00)	1732.00 (439.00)	3379.00 (311.00)	0.0001	0.89	0.0001*	0.0001*
Apgar Ratings: 1 minute	7.08 (1.38)	6.08 (1.93)	8.33 (0.78)	0.002	0.15	0.01	0.002*
Apgar Ratings: 5 minutes	8.50 (0.80)	8.08 (0.52)	8.92 (0.29)	0.004	0.15	0.11	0.0001*
Mean Daily Pulmonary Index (Days 1-2)	0.25 (0.26)	0.71 (0.62)	N/A	N/A	0.03	N/A	N/A
Obstetric Complications Scale Score	68.83 (12.19)	58.67 (10.76)	115.25 (17.13)	0.0001	0.04	0.0001*	0.0001*
Mother's Age (years)	28.33 (6.97)	28.83 (5.29)	30.42 (6.86)	0.71	0.85	0.47	0.53
Parity	0.50 (0.52)	0.50 (1.00)	0.92 (0.90)	0.38	1.00	0.18	0.30
Social Readjustment Rating Scale	0.19 (0.10)	0.19 (0.04)	0.19 (0.11)	0.99	0.85	0.97	0.90
Social Class (I & II; III; IV & V)	7 / 1 / 4	8 / 3 / 1	7 / 2 / 3	0.58	0.24	0.79	0.53
Marital Status (partner, single)	12 / 0	10 / 2	12 / 0	0.12	0.14	1.00	0.14
Ethnicity (Cauc., Afr.Am., Hisp., Other)	6 / 4 / 2 / 0	4 / 7 / 0 / 1	7 / 3 / 2 / 0	0.35	0.24	0.90	0.14

Results are means (SD). One-Way Analysis of Variance Test, Two-tailed: F, and Chi-Square Test, Two-tailed: $\chi 2$

*Pairwise Comparisons with Bonferroni adjustment for multiple comparisons ($p \leq .05$)

TABLE 3. APIB Subsystem Variables

	Group				Pairwise Comparisons		
	Preterm Control (I): n=12	Preterm Experimental (II): n=12	Fullterm Comparison (III): n=12	*p*	I&II *p*	I&III *p*	II&III *p*
Autonomic Organization	5.42 (1.41)	3.88 (0.60)	3.30 (1.02)	0.002	0.005*	0.01	0.53
Motoric Organization	5.04 (1.22)	3.70 (0.73)	3.43 (0.83)	0.004	0.006*	0.03	0.74
State Organization	4.40 (1.53)	3.07 (1.19)	3.27 (1.13)	0.07	0.04	0.25	0.86
Attentional Organization	5.74 (1.94)	3.65 (1.33)	4.58 (2.07)	0.05	0.02	0.39	0.56
Regulatory Organization	5.17 (1.42)	4.02 (0.83)	3.71 (0.97)	0.03	0.04	0.09	0.75
Examiner Facilitation	5.37 (1.56)	3.99 (1.44)	4.41 (1.30)	0.11	0.05	0.38	0.74

Results are adjusted means (SD). One-Way Analysis of Covariance Test, Two-tailed: F

*Pairwise Comparisons with Bonferroni adjustment for multiple comparisons ($p \leq .008$)

TABLE 4. APIB Summary Variables

	Group						
	Preterm Control (I): n=12	Preterm Experimental (II): n=12	Fullterm Comparison (III): n=12		Pairwise Comparisons		
					I&II	I&III	II&III
				p	*p*	*p*	*p*
Inhibition to stimuli in sleep	5.33 (2.79)	7.31 (1.79)	5.26 (2.72)	0.26	0.11	0.97	0.35
Capacity to maintain state stability when uncovered	4.87 (1.93)	6.40 (1.33)	7.54 (0.74)	0.01	0.03	0.02	0.36
Proportion of abnormal to normal reflexes	24.71 (11.06)	20.37 (12.65)	12.16 (8.33)	0.24	0.41	0.13	0.39
Pull to sit manuever	5.69 (1.58)	6.97 (1.62)	6.05 (1.71)	0.27	0.11	0.77	0.52
Cuddling and crawling behaviors	5.56 (1.01)	6.49 (1.03)	6.09 (1.07)	0.16	0.07	0.50	0.66
Motoric actions	6.56 (1.39)	7.17 (1.20)	6.52 (1.26)	0.61	0.33	0.97	0.56
Orientation ability	5.90 (1.33)	6.55 (0.97)	5.93 (1.63)	0.60	0.31	0.97	0.59
Autonomic parameters	5.71 (0.95)	6.50 (1.07)	7.33 (0.50)	0.02	0.07	0.02	0.28

133

TABLE 4. APIB Summary Variables (continued)

Motor maturity	5.61 (0.98)	5.65 (0.91)	6.81 (0.58)	0.001	0.01	0.001*	0.12
Activity level	6.33 (1.62)	7.06 (1.29)	7.40 (1.42)	0.37	0.30	0.32	0.79
Degree of alertness and manipulation during orientation	5.88 (1.65)	6.46 (1.01)	6.38 (1.72)	0.66	0.42	0.65	0.95
State regulation	4.43 (1.01)	5.59 (1.04)	5.54 (0.81)	0.02	0.02	0.13	0.95
Robust crying abilities	4.47 (1.63)	5.47 (1.46)	6.09 (1.75)	0.21	0.21	0.19	0.66
Stability measure	4.71 (1.09)	5.20 (0.98)	5.90 (1.14)	0.24	0.34	0.15	0.46
Attractiveness	4.78 (1.36)	5.80 (0.82)	6.59 (1.09)	0.03	0.06	0.04	0.42
Symmetry	7.20 (0.95)	6.72 (1.06)	7.83 (0.68)	0.34	0.27	0.36	0.17
Autonomic stress signals	0.68 (0.26)	0.74 (0.29)	0.76 (0.55)	0.91	0.74	0.78	0.96
Motoric stress signals	1.15 (0.58)	0.89 (0.47)	0.40 (0.35)	0.08	0.26	0.04	0.24
Motoric self-regulatory signals	1.46 (0.42)	1.48 (0.49)	2.24 (0.41)	0.07	0.91	0.02	0.06
State related signals	0.47 (0.26)	0.47 (0.47)	0.56 (0.28)	0.93	1.00	0.71	0.75
Attention related signals	0.85 (0.32)	0.78 (0.47)	0.99 (0.50)	0.86	0.77	0.66	0.59
Two most predominant states	3.69 (1.13)	4.19 (1.21)	4.11 (0.95)	0.58	0.35	0.61	0.93

Results are adjusted means (SD). One-Way Analysis of Covariance Test, Two-tailed: F

*Pairwise Comparisons with Bonferroni adjustment for multiple comparisons ($p \leq .008$)

TABLE 5. Prechtl Neurological Examination of the Full-term Newborn Infant

	Group						
	Preterm Control (I): n=12	Preterm Experimental (II): n=12	Fullterm Comparison (III): n=12	*p*	Pairwise Comparisons I&II *p*	I&III *p*	II&III *p*
Truncal and Limb Posture	1.62 (0.49)	0.86 (0.71)	0.52 (0.63)	0.01	0.02	0.02	0.53
Motility	0.51 (0.36)	0.26 (0.37)	-0.18 (0.30)	0.02	0.15	0.01	0.15
Pathological Movements	2.38 (1.66)	1.98 (1.34)	-0.53 (0.49)	0.01	0.51	0.004*	0.03
Motor System Tone	0.97 (0.51)	0.69 (0.48)	0.26 (0.50)	0.10	0.24	0.06	0.32
Intensity of Responses	0.08 (0.29)	0.02 (0.03)	-0.01 (0.001)	0.58	0.45	0.45	0.82
Threshold of Responses	0.00	0.00	0.00	1.00			
Moro Response	0.08 (0.30)	0.12 (0.27)	-0.03 (0.003)	0.74	0.70	0.52	0.44
State Stability	0.60 (0.50)	0.21 (0.46)	0.20 (0.39)	0.13	0.08	0.24	0.98
Crying	0.18 (0.42)	0.38 (0.39)	0.02 (0.39)	0.50	0.31	0.61	0.31
Hemisyndrome	0.70 (0.85)	0.80 (2.24)	0.33 (0.38)	0.93	0.88	0.73	0.70

TABLE 5. Prechtl Neurological Examination of the Full-term Newborn Infant (continued)

Syndromes of Abnormal Reactivity	0.60 (0.86)	-0.08 (0.39)	0.57 (0.42)	0.07	0.02	0.94	0.22
Summary Prechtl Score	7.71 (2.61)	5.23 (3.29)	1.14 (1.88)	0.003	0.06	0.002*	0.08

Results are adjusted means (SD). One-Way Analysis of Covariance Test, Two-tailed: F

*Pairwise Comparisons with Bonferroni adjustment for multiple comparisons ($p \leq .008$)

LIST OF FIGURES

Figure 1 APIB Subsystem Variables

Figure 2 APIB Summary Variables

Figure 3 Prechtl's Neurological Examination of the Full-Term Newborn Infant

Figure 4 Evoked Potential Regions of Among Group Difference

FIGURE LEGENDS

Fig. 1. Means and standard deviations of the APIB subsystem scores for the preterm control, preterm experimental, and fullterm comparison groups derived from the behavioral examination at 2 weeks post expected date of confinement (EDC). Behavioral systems are the autonomic system, the motor system, the state organizational system, the attentional system, the self regulatory system, and the degree of examiner facilitation necessary in the course of the examination. All system scores are scaled from 1 to 9, with 1 representing well-organized performance and 9 representing poorly organized performance. The six system scores are based on means of 18 scores per system obtained in the course of an examination for each child on the autonomic, motor, state, and self-regulation system; the means of three scores are obtained on the attentional system, and the means of six scores on the variable examiner facilitation.

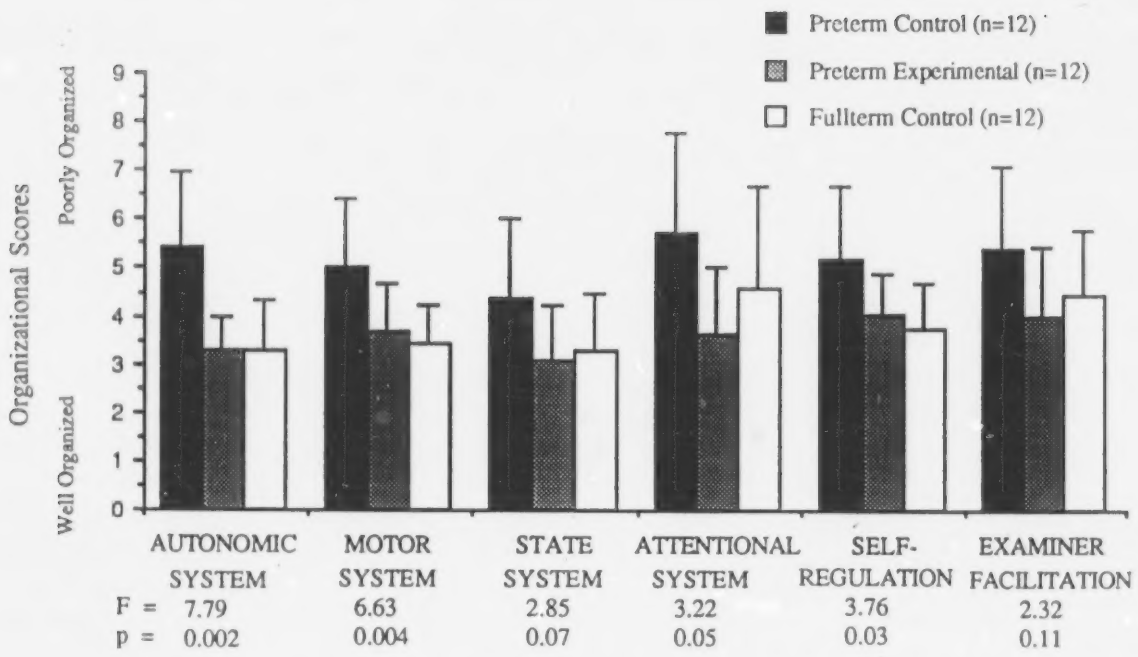

Figure 1

Buehler, et al.

Fig. 2. Means and standard deviations of the APIB summary scores showing significant differences between the preterm control, preterm experimental, and fullterm comparison groups at 2 weeks post-EDC. Summary scores are scaled from 1 to 9, with 1 representing poorly organized performance and 9 representing well-organized performance. State stability measures a combination of parameters which include lability of states, ability to quiet when motorically aroused, ability to be consoled when motorically aroused, rapidity of build up to motoric arousal, peak of motoric arousal, and degree of discharge smiles versus stimulus-related smiles in alertness. Autonomic parameters include the degree of tremulousness, startles, skin color lability and the threshold to color change. Motor maturity measures the degree of flaccidity versus hypertonicity and the degree of smoothness and control of limb movements. State regulation consists of the range and flexibility of states, irritability, robustness in handling the examination, control over input, and improvement with facilitation. Behavioral attractiveness measures the overall organization and modulation paired with social responsiveness and engagement.

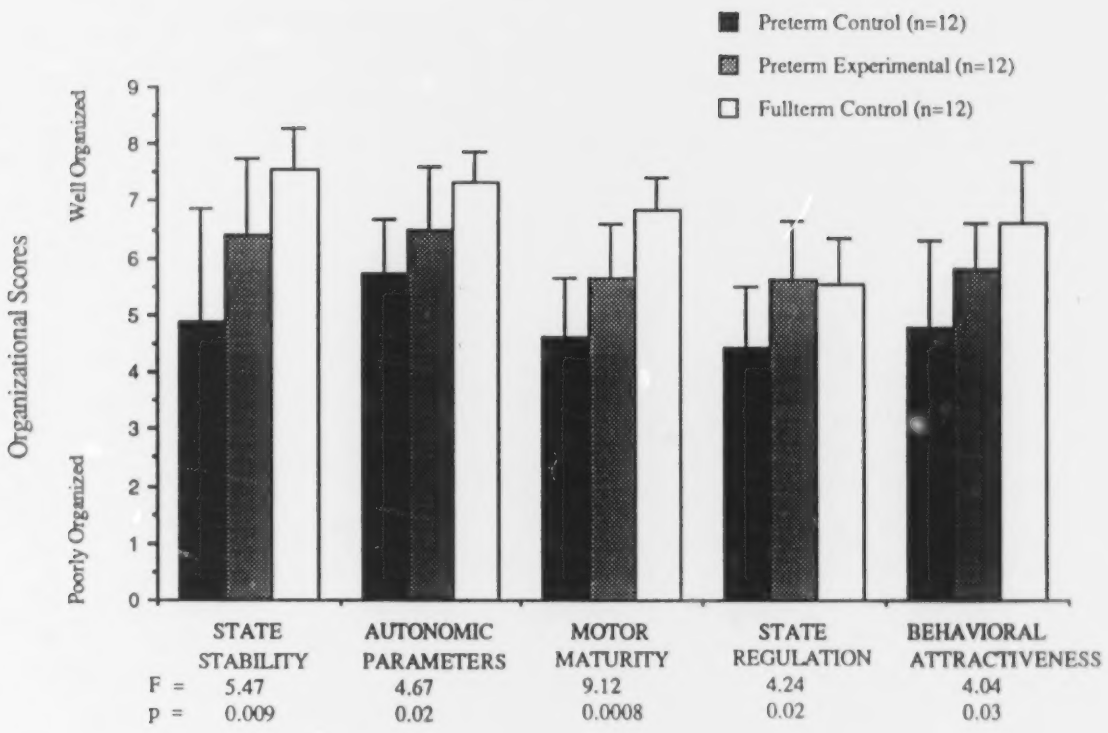

Figure 2

Buehler, et al.

Fig. 3. Means and standard deviations for those summary scales from the Prechtl Neurological Examination of the Full-term Newborn Infant showing significant differences among the three groups, preterm control, preterm experimental, and fullterm comparison groups. Posture measures the parameters of asymmetry, opisthotonos, and frog positioning. Motility includes hyperkinetic and hypokinetic patterns of movement. Pathological movements summarize overshooting movements, convulsions, twitching of the face, and the incidence, frequency, and amplitude of tremors. The total abnormal score summarizes all of the summary scales, including: posture, motility, pathological movements, motor system tone, intensity of the responses, the Moro response, state stability, crying, hemisyndrome, and syndromes of abnormal reactivity.

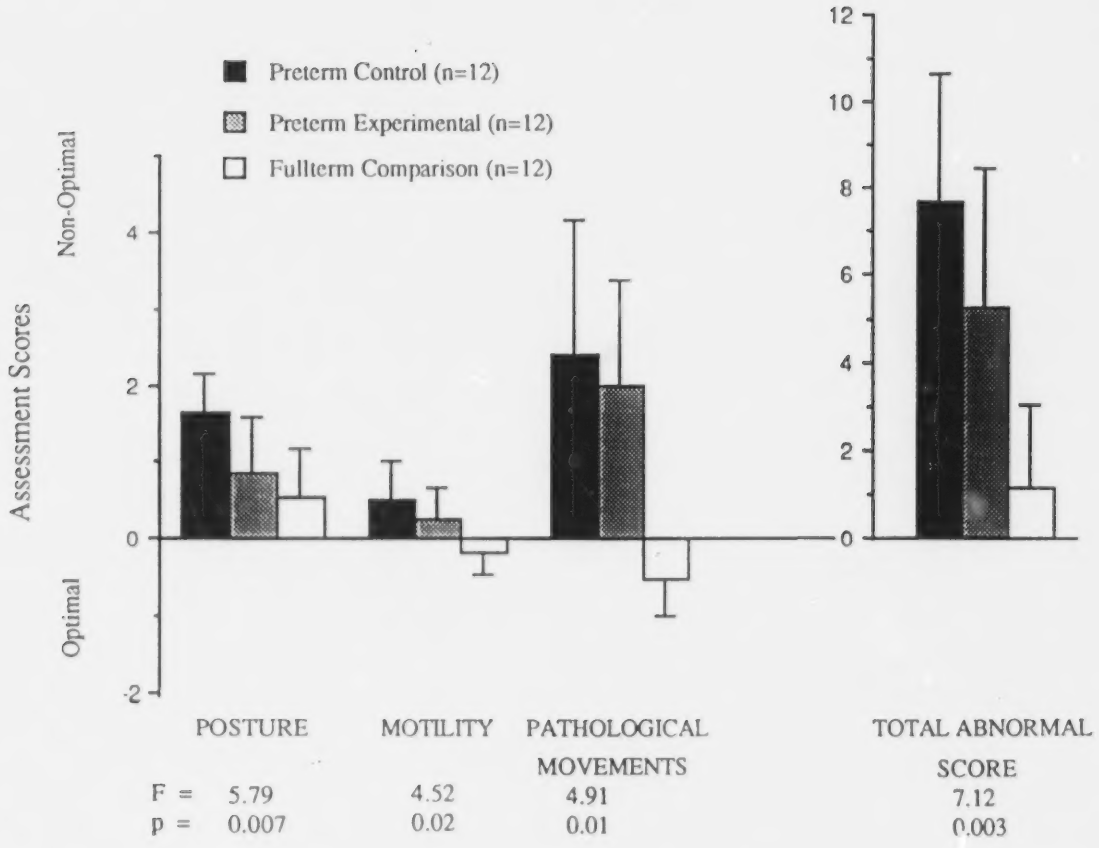

Figure 3

Buehler, et al.

Fig. 4. Forty-one regions of significant difference ($p \leq .05$) among the three groups are shown by qEEG with topographic mapping. Schematic representations are of head areas as seen from above (i.e. nose at top, right ear on right side), arranged by locations of regions of difference (ROIs): frontal, temporal, central, occipital, and parietal. Each individual representation indicates the region of difference (white area), evoked potential condition (VERA, VERQ, SPE, NSP, CLK), and starting msec of the 40 msec time period for which a significant between group difference was identified. The location of the electrode measuring the peak between group difference is in parentheses; identified by region (F = Frontal, FP = Fronto-Polar, T = Temporal, W = Wernicke's, C = Central, O = Occipital, P = Parietal) and side (odd numbers indicate left hemisphere, even numbers right hemisphere, and Z bihemispheric electrode placement).

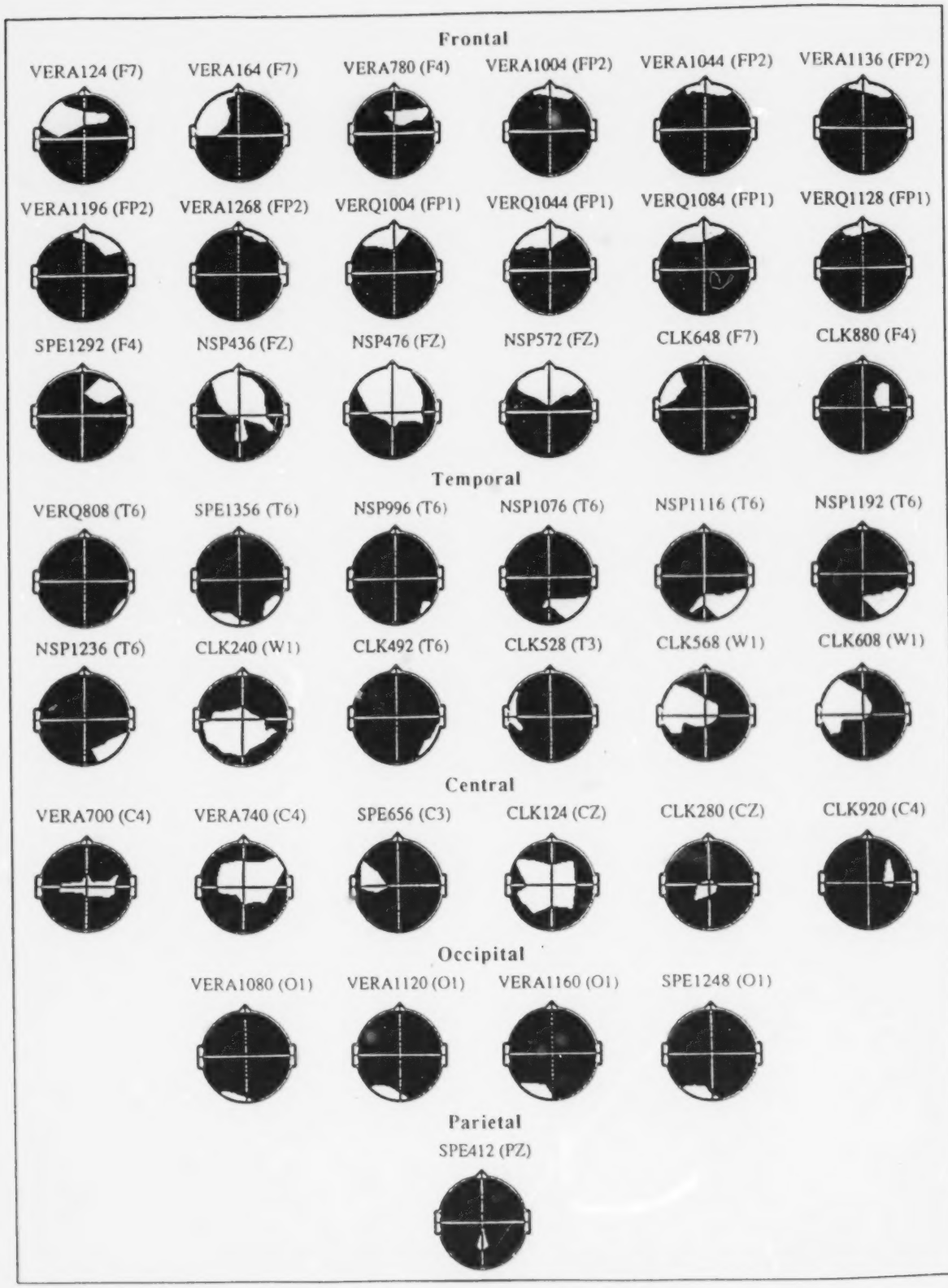
Frontal
VERA124 (F7)
VERA164 (F7)
VERA780 (F4)
VERA1004 (FP2)
VERA1044 (FP2)
VERA1136 (FP2)
VERA1196 (FP2)
VERA1268 (FP2)
VERQ1004 (FP1)
VERQ1044 (FP1)
VERQ1084 (FP1)
VERQ1128 (FP1)
SPE1292 (F4)
NSP436 (FZ)
NSP476 (FZ)
NSP572 (FZ)
CLK648 (F7)
CLK880 (F4)
Temporal
VERQ808 (T6)
SPE1356 (T6)
NSP996 (T6)
NSP1076 (T6)
NSP1116 (T6)
NSP1192 (T6)
NSP1236 (T6)
CLK240 (W1)
CLK492 (T6)
CLK528 (T3)
CLK568 (W1)
CLK608 (W1)
Central
VERA700 (C4)
VERA740 (C4)
SPE656 (C3)
CLK124 (CZ)
CLK280 (CZ)
CLK920 (C4)
Occipital
VERA1080 (O1)
VERA1120 (O1)
VERA1160 (O1)
SPE1248 (O1)
Parietal
SPE412 (PZ)

Figure 4

APPENDIX D

ORGANIZATIONAL STRUCTURES COMPONENT: TABLES

INTERVIEW SCHEDULE SUMMARY TABLE

HOSPITAL	# OF OSA VISITS	# OF INDIVIDUALS	# OF INTERVIEWS
Beth Israel	5	23	40
Children's Hospital -- Boston	5	14	27
Brigham & Women's Hospital	6	38	65
Oakland Children's Hospital	6	37	73
University Medical Center	6	50	90
TOTAL	28	162	295

APP D,Table 1

INTERVIEWEES' ROLE CATEGORIES

Table 2

ROLES	TOTAL
RESEARCH TEAM	20
MEDICAL ROLES	22
NURSING ROLES	79
PARENT ROLES	12
MULTI-DISCIPLINARY ROLES	15
POST-NICU ROLES	12
OTHER	2
TOTAL	**162**

BETH ISRAEL
INTERVIEW SCHEDULE

OSA VISIT	DATE	INITIAL INTERVIEW	REPEAT INTERVIEW	TOTAL
1	8/21-23/90	6	0	6
2	1/14/91	6	1	7
3	2/22-24/91	5	5	10
4	4/20-24/92	5	4	9
5	10/27-29/92	2	6	8
TOTAL		24	16	40

BETH ISRAEL
ROLES OF INTERVIEWEES

ROLES	# OF INDIVIDUALS	# OF INTERVIEWS
RESEARCH TEAM		
Principal Investigator	1	5
Developmental Specialist	2	5
TOTAL	3	10
MEDICAL ROLES		
Medical Director	2	5
Attendings/Fellows	3	3
TOTAL	5	8
NURSING ROLES		
Nursing Manager/Director	1	4
Clinical Nurse Specialist	1	2
Staff Nurses	7	7
Nurse Liaison	1	2
TOTAL	10	15
PARENT ROLES		
Mother/Grandmother	2	2
TOTAL	2	2
MULTIDISCIPLINARY ROLES		
Occupational Therapist	1	1
Physical Therapist	1	1
Social Work	1	1
TOTAL	3	3

CHILDREN'S HOSPITAL -- BOSTON
INTERVIEW SCHEDULE

OSA VISIT	DATE	INITIAL INTERVIEW	REPEAT INTERVIEW	TOTAL
1	7/23-25/90	5	0	5
2	3/25-27/91	3	3	6
3	10/28-30/91	1	4	5
4	4/20-24/92	3	3	6
5	10/27-29/92	2	3	5
TOTAL		14	13	27

CHILDREN'S HOSPITAL -- BOSTON
ROLES OF INTERVIEWEES

ROLES	# OF INDIVIDUALS	# OF INTERVIEWS
RESEARCH TEAM		
Developmental Specialist	1	4
TOTAL	1	4
MEDICAL ROLES		
Medical Director	1	2
Attendings/Fellows	1	1
TOTAL	2	3
NURSING ROLES		
Nursing Manager/Director	2	6
Staff Nurses	5	6
Nurse Liaison	2	6
TOTAL	9	18
PARENT ROLES		
Mother/Grandmother	2	2
TOTAL	2	2

BRIGHAM & WOMEN'S HOSPITAL
INTERVIEW SCHEDULE

OSA VISIT	DATE	INITIAL INTERVIEW	REPEAT INTERVIEW	TOTAL
Baseline	1/15-17/90	4	0	4
1	7/23-25/90	10	2	12
2	3/25-27/91	8	5	13
3	10/28-30/91	6	6	12
4	4/20-24/92	8	3	11
5	10/27-29/92	2	11	13
TOTAL		38	27	65

BRIGHAM & WOMEN'S HOSPITAL
ROLES OF INTERVIEWEES

ROLES	# OF INDIVIDUALS	# OF INTERVIEWS
RESEARCH TEAM		
Principal Investigator	2	2
Developmental Specialist	3	6
Family Specialists	1	3
TOTAL	6	11
MEDICAL ROLES		
Medical Director Assistant Director	2	7
Attendings/Fellows	7	9
TOTAL	9	16
NURSING ROLES		
Nursing Manager/Director	3	6
Clinical Nurse Specialist Staff Education	3	7
Staff Nurses	7	7
Nurse Liaison	1	6
TOTAL	14	26
PARENT ROLES		
Mother/Grandmother	1	1
Father	1	1
TOTAL	2	2
MULTIDISCIPLINARY ROLES		
Physical Therapist	1	1
Social Work	2	4
TOTAL	3	5
POST-NICU ROLES		
Early Intervention	2	2
Infant Follow-Up	1	2
TOTAL	3	4
OTHER		
Unit Secretary	1	1
TOTAL	1	1

OAKLAND CHILDREN'S HOSPITAL
INTERVIEW SCHEDULE

OSA VISIT	DATE	INITIAL INTERVIEW	REPEAT INTERVIEW	TOTAL
Baseline	6/25-27/90	14	0	14
1	1/28-30/90	7	7	14
2	9/23-25/91	6	11	17
3	-	-	-	-
4	6/8-10/92	7	9	16
5	11/9-11/92	4	8	12
TOTAL		38	35	73

OAKLAND CHILDREN'S HOSPITAL
ROLES OF INTERVIEWEES

ROLES	# OF INDIVIDUALS	# OF INTERVIEWS
RESEARCH TEAM		
Principal Investigator	3	11
Co-Principal Investigator		
Developmental Specialist	3	13
TOTAL	6	24
MEDICAL ROLES		
Medical Director	2	4
Attendings/Fellows	1	2
TOTAL	3	6
NURSING ROLES		
Nursing Manager/Director	3	3
Assoc. Nurse Manager	2	2
Clinical Nurse Specialist	1	2
Staff Education		
Staff Nurses	15	23
Nurse Liaison	1	1
TOTAL	22	31
PARENT ROLES		
Mother/Grandmother	1	1
TOTAL	1	1
MULTIDISCIPLINARY ROLES		
Child Life	1	1
Physical Therapist	1	1
Volunteer Coordinator	2	3
TOTAL	4	5
POST-NICU ROLES		
Infant Mental Health	1	1
TOTAL	1	1

UNIVERSITY MEDICAL CENTER - TUCSON
INTERVIEW SCHEDULE

OSA VISIT	DATE	INITIAL INTERVIEW	REPEAT INTERVIEW	TOTAL
Baseline	4/23-25/90	12	0	12
1	10/17-19/91	11	4	15
2	5/7-9/91	9	9	18
3	11/12-14/91	9	9	18
4	8/5-7/92	7	9	16
5	2/17-19/93	3	8	11
TOTAL		51	39	90

UNIVERSITY MEDICAL CENTER - TUCSON
ROLES OF INTERVIEWEES

ROLES	# OF INDIVIDUALS	# OF INTERVIEWS
RESEARCH TEAM		
Principal Investigator	2	7
Developmental Specialist	1	6
Assessor	1	4
TOTAL	4	17
MEDICAL ROLES		
Medical Director	1	2
Attendings/Fellows	2	4
TOTAL	3	6
NURSING ROLES		
Nursing Manager/Director	2	6
Assist. Nurse Manager	3	3
Neonatal Nurse Practitioner	2	3
Staff Nurses	15	22
Nurse -- Developmental	2	4
TOTAL	24	38
PARENT ROLES		
Mother/Grandmother	4	4
Father	1	1
TOTAL	5	5
MULTIDISCIPLINARY ROLES		
Discharge Planner	1	5
Occupational Therapist	1	1
Respiratory Therapist	1	1
Social Work	1	1
Volunteers	1	1
TOTAL	5	9

POST-NICU ROLES		
Infant Follow-Up	3	3
Early Intervention	4	5
State Agency	1	1
TOTAL	8	9
OTHER		
Laboratory Manager	1	1
TOTAL	1	1

Appendix E

Reflective Process Work in the NICU: Instruments

Taking the Pulse: Understanding the Dynamics of Your Unit
Linda Gilkerson, PhD

I. Life, Vitality, and Distinctive Competence (Cooperrider & Srivasta, 1992)

a. Your Unit:

b. Yourself:

c. Reflections on the Opportunities/Challenges:

II. Nursery Features (Gilkerson & Als, 1993)

a. Site Complexity: ___ Hi ___ Med ___ Lo

b. Family Complexity: ___ Hi ___ Med ___ Lo

c. Resources to Manage Complexity: ___ Hi ___ Med ___ Lo

d. Reflections on the Opportunities/Challenges:

Gilkerson NCRI, 1993

III. Primary Relationships

a. Social Identities

b. Conflict Management Styles (Shortell & Rousseau, 1989)

MD/RN: ___ Avoidance ___ Compromise ___ Forcing
___ Problem Solving ___ Referral Up

RN/RN: ___ Avoidance ___ Compromise ___ Forcing
___ Problem Solving ___ Referral Up

Your ___ Avoidance ___ Compromise ___ Forcing
c. Reflections on ... Problem Solving ___ Referral Up

IV. Unit State (Gilkerson, 1993)

a. Contextual Variables

Financial Stability:	___ Hi	___ Med	___ Lo
Staff Conflict:	___ Hi	___ Med	___ Lo
Staff Changes:	___ Hi	___ Med	___ Lo
Critical Events:	___ Hi	___ Med	___ Lo

b. Systems Balance

___ Disequilibrium

___ Equilibrium

___ Transition toward Equilibrium

___ Transition toward Disequilibrium

c. Shared Affect

d. Reflections on the Opportunities/Challenges:

V. Practice Concern

VI. Considerations from Systems Perspective

VII. Next Steps

VIII. Support System in Your Setting

Consultation and Guidance with Sites

Preliminary Draft

Heidelise Als, Ph.D.
Harvard Medical School
Children's Hospital
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Introduction

An important component of NIDCAP training and developmental care education is consultation to sites seeking training in terms of guiding them towards the development of organizational structures supportive of the integration of developmental care. Any training visit to the site should be planned with the developmental leadership persons at the site and should encompass a reflective consultation, feedback, and guidance session before the end of the visit. This typically requires a minimum of 2 hours. Depending on the site and its progress, representatives from several disciplines should be present. As an absolute minimum, the nurse manager and the medical director or his or her deputy should be present. Eventually, representation from respiratory therapy and social work, occupational, physical and speech and language therapy, as well as from early childhood education, parent council, and psychology is the goal. The specific trainees targeted to become the developmental leaders at the site should also be present. The trainer will want to have structured the opportunity, in the course of the training at the site, to meet individually with the key representatives of the site consultation. This is valuable in gaining understanding of the dynamics at a site, its history, and possibilities for growth, which may not be immediately apparent to those intimately involved in attempting to bring about the integration of developmental care. The format for consultation with individual site professionals may in general terms be based on the consultation with individual trainees, and is tailored in length and depth to the professional and his or her role in the context of the site and the developmental care effort. Following is a document which provides a format for the suggested structure of overall site consultation and guidance.

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Date: _____

Trainer: _____

Institution: _____

Location: _____

Name of the Organizer(s): _____

Prior Site Experience: _____

Current Training: _____

PART I: ASSESSMENT OF THE TRAINING SITE

Reflect on your observation of and work with the site; and consider the points below

A. Description of Context

Prior contacts; first impressions; sequence of events; changes in flow; unexpected occurrences

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B. Assessment of the Physical Environment of the Hospital in General, and the NICU Specifically

Reflect in detail on the path to the infant, organization, cleanliness, aesthetic appeal, comfort, and atmosphere in regards to the conceptualization of developmental care

1. Description and Schematic Representation of the Physical Environment

2. Environment's Specific Observed Advantages, Challenges, and Difficulties

   a. Physical Layout and Spaciousness

   b. Cleanliness and Aesthetic Considerations

   c. Family and Child Sensitivity of the Environment
   (Living-in, sleeping, bathing, special comfort areas, sibling corner)

d. Staff Sensitivity of the Environment
(Sleeping, eating, special comfort areas, etc.)

3. Considerations and Suggestions for Modification

a. Readily Modifiable Aspects

b. Aspects requiring longterm planning

C. Assessment of the Lead Discipline(s) Supporting Developmental Care
Reflect on your interactions with the representatives of the lead discipline(s) supporting developmental care. Consider representatives from the disciplines of

- Nursing
- Neonatology
- Respiratory Therapy
- Social Work
- Physical Therapy
- Occupational Therapy
- Speech and Language Therapy
- Early Childhood Education
- Parent Council and Representation
- Developmental & Clinical Psychology
- Other Disciplines

1. Names, Titles, and Roles of Representatives:

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

2. Key professionals' Observed Strengths and Challenges

Consider

- Personal bearing, presentation, and physical appearance
- Interactive competence
- Background and knowledge
- Organizational skill and skill in appreciation of the broad context
- Ambition, drive, energy, and enthusiasm
- Clinical sensitivity and skill
- Generosity and nurturing skill
- Mentoring and leadership skill

a. _____

b. _____

c. _____

d. _____

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e. _____

_____

_____

_____

f. _____

_____

_____

_____

g. _____

_____

_____

_____

h. _____

_____

_____

i. _____

_____

_____

_____

* Use additional pages as needed to reflect on other hospital representatives

3. Lead disciplines' current goals, as inferred from discussions and observations

D. Assessment of the Interdisciplinary Developmental Leadership and Integrative Implementation of Developmental Care

Reflect on your observation of discussion, and work with the different professionals from the different disciplines in this setting and describe the organizational structures in place and professionals involved, e.g. work groups, committees, rounds, educational opportunities, etc., working towards integrative implementation of developmental care.

- Organizational Structures in Place and Professionals Involved

- Strengths and Challenges

- Disciplines which are currently not represented

E. Site's Current Goals and Plans

PART II: GUIDED SELF ASSESSMENT WITH THE SITE

Explore in group discussion with the site representatives how they perceive themselves in respect to the process of developmental care integration

List Names and Disciplines of Persons Present

Guiding Questions

A. What were your anticipations for the current visit (training session) and how did it go for you?

B. What strengths of your system (yourself) did preparation and conduct of the visit (training session) draw on?

Did you anticipate this?

How do you feel about it?

C. What has presented the most challenge for your site?

Did you anticipate this?

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How do you feel about it?

D. What do you see as the next steps for your site?

E. What would you find most helpful in accomplishing those steps?

F. What difficulties do you anticipate in the course of the path?

PART III: JOINT FORMULATION OF THE NEXT STEPS, AND ANTICIPATED SPECIFIC TIMELINES.

Integrate your assessment with the site's self assessment.

A. Give feedback to the site leadership participants regarding the strengths and challenges you have identified and articulate their specific value in the site's progress towards its goals, amplify on specific opportunities for growth towards the next steps, as indicated:

- The environment

- The specific trainees you worked with

- The level of implementation of developmental care you observed

- The level of interdisciplinary leadership you observed

- The level of organizational structures in place you observed

- Other features you have become aware of

B. Clearly summarize your assessment of the specific accomplishments of this particular visit or training component.

C. Summarize an overview of the specifics of the bigger picture of the training process for individuals and for site development towards a process of increasing developmental care implementation; discuss lines of organization, opportunities for guidance, support structure development, and the specific next steps and responsibilities for each of the disciplines' leaders, and for the specific trainees involved.

D. Discuss site professionals' joint time line development and follow up communication with you and plan timeframe for the next step(s)

E. Collect site evaluations of your training.

PART IV: TRAINER'S SELF EVALUATION

	Poor	Adequate	Excellent
A. Preparation of Materials for the Visit	____	____	____
B. Preparation of Information Gathering and Planning for the Visit	____	____	____
C. Planned Schedule	____	____	____
D. Time Management	____	____	____
E. Supportiveness to the key organizer	____	____	____
F. Supportiveness to interdisciplinary growth	____	____	____
G. Openness to listen and understand the site's issues	____	____	____
H. Clarity of communication and feedback offered	____	____	____
I. Constructiveness and creativity of guidance offered	____	____	____
J. Effectiveness of the training and guidance performed	____	____	____
K. Emotional energy and generosity provided	____	____	____
L. Intellectual energy and generosity provided	____	____	____

Errors made; opportunities missed; regrets

_____

_____

_____

Decision for changes and next steps

_____

_____

_____

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PART V: SUMMARY.

Summarize the overall assessment of the specific training component and the site
A. Specific Training Goals and Results

1. Specific Training Results
   Indicate the result for each of the specific training goals, in terms of:

   Not Accomplished _____; Progress _____; Reliability_____

Goal a. _____

Goal b. _____

Goal c. _____

Goal d. _____

Other:

_____

Comments:

_____

_____

_____

_____

2. Site Self Assessment

   Over Estimation _____ Under Estimation _____ Accurate _____

   Comments:

_____

_____

_____

_____

_____

_____

_____

3. Feedback and Reflective Process Session

   Poorly Recd. _____ Recd. with Some Difficulty _____ Well Recd. _____

   Comments:

4. Training Effectiveness

   Trainer contributed to difficulties _____

   Training was well conducted overall _____

5. Training Deposition

   Terminate/Postpone Further Training ____

   Continue/Overall Productive ____

   Ready for Next Step/Excellent ____

6. Summary of Next Steps Discussed

Comments:

PART VI: WRITTEN SUMMARY.

Follow up with a written communication summarizing the main points outlined in Part III, IV, and V, in form of a letter addressed to the key organizer of training with copies to the supervisor or chief of the key persons, as well as the key leaders of the other disciplines represented at the reflective site meeting consultation. A copy also should be sent to the other trainers involved in training at the site and to H. Als, the National Director of Training.

Consultation and Guidance with Individual Trainees

Preliminary Draft

Heidelise Als, Ph.D.
Harvard Medical School
Children's Hospital
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Introduction

An important component of NIDCAP training and developmental care education is consultation to individual trainees seeking training in terms of guiding their understanding of themselves, their history, strengths, challenges, and their goals and aspirations.

Following is a document that provides a format for the suggested structure of consultation and guidance with an individual trainee.

H. Als, 1994
Harvard Medical School

Date: _____

Trainer: _____

Location: _____

Trainee: _____

Institution: _____

Discipline: _____

Prior Developmental Care Related Experience: _____

Current Training: _____ _____

PART I: ASSESSMENT OF THE TRAINEE

Reflect on your observation of and work with the trainee, and consider the points below.

1. Description of Context
   Prior contact; first impression; sequence of events; changes in flow; unexpected occurrences

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

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2. Trainee's Specific Observed Strengths and Challenges

   Describe in terms of:

   - Personal Bearing and Presentation, including Physical Appearance
   - Interactive Competence
   - Background and Knowledge
   - Organizational Skill
   - Appreciation of the Bigger Context of Developmental Care
   - Ambition, Drive, Energy, and Enthusiasm
   - Emotional Security and Maturity
   - Clinical Sensitivity and Skill
   - Generosity and Nurturing Skills
   - Mentoring and Leadership Skill
   - Overall Perceived Power and Effectiveness

Trainee's Strengths _____

Trainee's Challenges

3. Trainee's Current Apparent Goals, As Inferred from your Interactions and Observations

Overall Summary

PART II: GUIDED REFLECTIVE SELF ASSESSMENT WITH THE TRAINEE
Explore in discussion with the trainee how the trainee perceives himself or herself with respect to the specific training component.

Guiding Questions:

1. What were your anticipations for this session and how did it go for you?

2. What strengths of yours did the session draw on?

   Did you anticipate this? — How do you feel about it?

3. What presented the most challenge to you?

   Did you anticipate this? — How do you feel about it?

4. What, as you see it, are the next steps for you?

5. What would you find most helpful in accomplishing these steps?

6. What difficulties do you anticipate in the course of the path?

PART III: FEEDBACK AND PLANNING

Integrate your and the trainee's self assessment, and formulation jointly next steps with integration into the bigger picture of the site and with an anticipated time line.

1. Give feedback to the trainee regarding the strengths you identified in the trainee and articulate their value in support of the trainee's self stated goals.

2. Give feedback to the trainee regarding the difficulties you identified in the trainee, articulate their impact on the trainee's self stated goals and amplify on specific opportunities for growth towards the next steps, as indicated.

3. Clearly state your assessment of the trainee's current level of specific training accomplishment.

4. Summarize an overview of the specifics of the bigger picture of the training process and the trainee's site's development, discuss lines of organization, opportunities for guidance, support structure development, and the specific next steps and responsibilities for the trainee.

5. Develop a timeline with the trainee and/or plan a timeframe for specific next steps.

6. Collect the trainee's overall evaluation of the session, including the evaluation of this guidance component.

PART IV: TRAINER'S SELF EVALUATION.
Reflect on the experience of this particular session and on areas that may be improved for future training.

		Poor	Adequate	Excellent
1.	Environment Provided	____	____	____
2.	Scheduling	____	____	____
3.	Preparation of Materials	____	____	____
4.	Facilitation of Comfort	____	____	____
5.	Time Management	____	____	____
6.	Supportiveness of Trainee	____	____	____
7.	Openness to Listen and Understand the Trainee's Issues	____	____	____
8.	Clarity of Communication and Feedback Offered	____	____	____
9.	Constructiveness and Creativity of Guidance Offered	____	____	____
10.	Effectiveness of the Training Performed	____	____	____
11.	Emotional Energy Level and Generosity Provided	____	____	____
12.	Intellectual Energy and Generosity Provided	____	____	____

Errors Made, Opportunities Missed, Regrets: _____

_____

_____

_____

_____

_____

_____

Trainer's Decision for Changes and Next Steps:

_____

_____

_____

_____

_____

_____

PART V: OVERALL SUMMARY OF THE TRAINING SESSION.

The trainer summarizes the overall assessment of the trainee and the session.

1. Training Result

   Not accomplished _____ Progress _____ Reliable _____

   Comments:

_____

_____

_____

_____

2. Trainee Self Assessment

   Over-estimation _____ Under-estimation _____ Accurate _____

   Comments:

_____

_____

_____

_____

3. Feedback and Reflective Process Session

   Poorly Rec'd. _____ Recd. with Difficulty _____ Well Recd. _____

   Comments:

4. Trainer Effectiveness

   Trainer Contributed to Difficulties _____

   Aspects of Training Session Well Conducted _____

5. Training Disposition

   Terminate Training or Postpone _____

   Some Difficulty/Overall Productive/Continue _____

   Excellent/Move to Next Level _____

   Comments:

6. Next Steps Discussed _____

_____

_____

_____

_____

Comments:

_____

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_____

Part VI: WRITTEN SUMMARY.
Follow up with a written communication summarizing the main points outlined in Part III, IV, and V, in form of a letter addressed to the trainee, with copies to the trainee's immediate supervisor and other mentors, as indicated, as well as any other trainers involved in working with the trainee and/or at the site.

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Harvard Medical School

Consultation and Guidance with Individual Trainees

Preliminary Draft

Heidelise Als, Ph.D.
Harvard Medical School
Children's Hospital
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Introduction

An important component of NIDCAP training and developmental care education is consultation to individual trainees seeking training in terms of guiding their understanding of themselves, their history, strengths, challenges, and their goals and aspirations.

Following is a document that provides a format for the suggested structure of consultation and guidance with an individual trainee.

H. Als, 1994
Harvard Medical School

Date: _____

Trainer: _____

Location: _____

Trainee: _____

Institution: _____

Discipline: _____

Prior Developmental Care Related Experience: _____

Current Training: _____

PART I: ASSESSMENT OF THE TRAINEE

Reflect on your observation of and work with the trainee, and consider the points below.

1. Description of Context
   Prior contact; first impression; sequence of events; changes in flow; unexpected occurrences

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

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2. Trainee's Specific Observed Strengths and Challenges

Describe in terms of:

- Personal Bearing and Presentation, including Physical Appearance
- Interactive Competence
- Background and Knowledge
- Organizational Skill
- Appreciation of the Bigger Context of Developmental Care
- Ambition, Drive, Energy, and Enthusiasm
- Emotional Security and Maturity
- Clinical Sensitivity and Skill
- Generosity and Nurturing Skills
- Mentoring and Leadership Skill
- Overall Perceived Power and Effectiveness

Trainee's Strengths _____

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Trainee's Challenges

3. Trainee's Current Apparent Goals, As Inferred from your Interactions and Observations

Overall Summary

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PART II: GUIDED REFLECTIVE SELF ASSESSMENT WITH THE TRAINEE
Explore in discussion with the trainee how the trainee perceives himself or herself with respect to the specific training component.

Guiding Questions:

1. What were your anticipations for this session and how did it go for you?

2. What strengths of yours did the session draw on?

   Did you anticipate this? — How do you feel about it?

3. What presented the most challenge to you?

   Did you anticipate this? — How do you feel about it?

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4. What, as you see it, are the next steps for you?

5. What would you find most helpful in accomplishing these steps?

6. What difficulties do you anticipate in the course of the path?

PART III: FEEDBACK AND PLANNING

Integrate your and the trainee's self assessment, and formulation jointly next steps with integration into the bigger picture of the site and with an anticipated time line.

1. Give feedback to the trainee regarding the strengths you identified in the trainee and articulate their value in support of the trainee's self stated goals.

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2. Give feedback to the trainee regarding the difficulties you identified in the trainee, articulate their impact on the trainee's self stated goals and amplify on specific opportunities for growth towards the next steps, as indicated.

3. Clearly state your assessment of the trainee's current level of specific training accomplishment.

4. Summarize an overview of the specifics of the bigger picture of the training process and the trainee's site's development, discuss lines of organization, opportunities for guidance, support structure development, and the specific next steps and responsibilities for the trainee.

5. Develop a timeline with the trainee and/or plan a timeframe for specific next steps.

6. Collect the trainee's overall evaluation of the session, including the evaluation of this guidance component.

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PART IV: TRAINER'S SELF EVALUATION.
Reflect on the experience of this particular session and on areas that may be improved for future training.

		Poor	Adequate	Excellent
1.	Environment Provided	____	____	____
2.	Scheduling	____	____	____
3.	Preparation of Materials	____	____	____
4.	Facilitation of Comfort	____	____	____
5.	Time Management	____	____	____
6.	Supportiveness of Trainee	____	____	____
7.	Openness to Listen and Understand the Trainee's Issues	____	____	____
8.	Clarity of Communication and Feedback Offered	____	____	____
9.	Constructiveness and Creativity of Guidance Offered	____	____	____
10.	Effectiveness of the Training Performed	____	____	____
11.	Emotional Energy Level and Generosity Provided	____	____	____
12.	Intellectual Energy and Generosity Provided	____	____	____

Errors Made, Opportunities Missed, Regrets: _____

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Trainer's Decision for Changes and Next Steps:

PART V: OVERALL SUMMARY OF THE TRAINING SESSION.

The trainer summarizes the overall assessment of the trainee and the session.

1. Training Result

   Not accomplished _____ Progress _____ Reliable _____

   Comments:

2. Trainee Self Assessment

   Over-estimation _____ Under-estimation _____ Accurate _____

   Comments:

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3. Feedback and Reflective Process Session

   Poorly Rec'd. _____ Recd. with Difficulty _____ Well Recd. _____

   Comments:

4. Trainer Effectiveness

   Trainer Contributed to Difficulties _____

   Aspects of Training Session Well Conducted _____

5. Training Disposition

   Terminate Training or Postpone _____

   Some Difficulty/Overall Productive/Continue _____

   Excellent/Move to Next Level _____

   Comments:

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6. Next Steps Discussed _____

_____

_____

_____

_____

Comments:

_____

_____

_____

_____

_____

_____

_____

_____

Part VI: WRITTEN SUMMARY.
Follow up with a written communication summarizing the main points outlined in Part III, IV, and V, in form of a letter addressed to the trainee, with copies to the trainee's immediate supervisor and other mentors, as indicated, as well as any other trainers involved in working with the trainee and/or at the site.

Site Assessment

Preliminary Draft

Heidelise Als, Ph.D.
Harvard Medical School
Children's Hospital
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Introduction

An important component of developing one's site towards increasingly effective functioning in a developmental care model is understanding the organizational structures supportive of the integration of developmental care. Therefore, it is important to reflect on and explore already existing skills and support from within the setting; as well as perceptions and supports within and across all disciplines in the NICU.

The following document provides a format for the identification and articulation of the supports and structures available in a nursery. Please, make the information available to the NIDCAP trainer in advance of the first formal training sessions. It provides the starting point for joint reflection and assessment of the opportunities at a site as well as a base for site consultation, guidance, and timeline development.

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Date: _____

Hospital Name: _____

Hospital Address: _____

_____

_____

Phone Number: _____

Hospital's Institutional Affiliations (Medical School, Country, etc.): _____

Nursery Name(s) : _____

Contact Person(s): _____

Discipline(s) of Contact Person(s): _____

Nursery Phone Number: _____

Nursery Fax Number: _____

Names of Person(s) Filling Out Questionnaire: _____

Discipline of and Position of Person(s) filling out questionnaire _____

ASSESSMENT OF THE NURSERY SETTING

A. Specific Hospital and Nursery Characteristics

Describe the physical and caregiving practice characteristics of your nursery.

1. Hospital Mission(s) (check all those that apply and order in sequence of priority) _____

Research _____

Patient Care _____

Teaching _____

Other (specify) _____

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2. Hospital Service (check all those that apply)

   a. Children's Hospital: Transport Facility _____

   b. Women's Hospital _____

   c. Adult Hospital _____

   d. General Hospital _____

   e. Other (specify) _____

3. Type of facility (check all that apply) _____

   a. Tertiary Care Center _____

   b. Secondary Care Center (Community Hospital) _____

   c. Primary Care Center _____

   d. Other _____

4. Level of care provided in nursery with number of beds per level

   # of beds/level

   a. Intensive (Level III) _____

   b. Intermediate (Level II) _____

   c. Healthy Newborn (Level I) _____

   d. Extended Care Facility (Rehabilitation Setting) _____

   e. Other (specify; e.g., surgical, ECMO) _____

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5. Range of ages cared for in nursery (specify in weeks post conception)

_____

6. Range of services provided (check all those that apply)

a. Transport _____

b. Inborn _____

c. Surgical _____

d. ECMO _____

e. Re-admissions _____

f. Other (specify) _____

7. Population served (e.g., geographical range of communities served, ethnicities, socio-economic groups, languages spoken, etc.)

_____

_____

_____

_____

_____

8. Specifics of nursery population, including average census by level of care and gestational age at birth, average length of hospitalization, average age of infants, reasons admitted, etc.

_____

_____

_____

_____

_____

B. Specific Leadership Structures

Within each discipline, list the names with the corresponding titles of the hospital staff filling each of the leadership positions within the nursery/hospital system. Describe and graph the leadership structures within each of these disciplines, including how they are integrated into the nursery. Add, delete, and substitute titles as appropriate for your site.

1. Neonatology

Chairperson of Dept. of Pediatrics or Medicine _____

Chairperson of Newborn Medicine: _____

Clinical Director: _____

Nursery Director: _____

Key Neonatology Attending Physician(s): _____

Other Neonatologist Leader(s): _____

_____

Organizational diagram of medical staff hierarchy:

2. Nursing

Director, VP of Professional Services: _____

Director of OB/GYN: _____

Nurse Manager: _____

Clinical Nurse Specialist(s): _____

Leadership Staff Nurse(s): _____

Organizational diagram of nursing staff hierarchy:

Organizational Structures in Place (e.g., clinical ladder, union organization, primary nursing, etc.):

_____

_____

_____

3. Physical Therapy

Chief to whom Physical Therapy Director is Responsible: _____

Physical Therapy Director: _____

Key Unit Physical Therapist(s): _____

Discipline's role in unit: _____

_____

_____

4. Occupational Therapy

Chief to whom Occupational Therapy Director is Responsible: _____

Occupational Therapy Director: _____

Key Unit Occupational Therapist(s): _____

Discipline's role in unit: _____

_____

_____

5. Respiratory Therapy

Chief to whom Respiratory Therapy Director is Responsible: _____

Respiratory Therapy Director: _____

Key Unit Respiratory Therapist(s): _____

Discipline's role in unit: _____

_____

_____

6. Social Work

Chief to whom Social Work Director is Responsible: _____

Social Work Director: _____

Key Unit Social Worker(s): _____

Discipline's role in unit: _____

_____

_____

7. Speech and Language Specialty

Chief to whom Speech and Language Specialty Director is Responsible: _____

Speech and Language Specialist Director: _____

Key Unit Speech and Language Specialist(s): _____

Discipline's role in unit: _____

_____

_____

8. Psychology/Psychiatry

   Chief to whom Psychology/Psychiatry

   Director is Responsible _____

   Psychology/Psychiatry Director: _____

   Key Unit Psychologist/Psychiatrist(s): _____

   Discipline's role in unit: _____

   _____

   _____

9. Child Life Specialty

   Chief to whom Child Life Specialty

   Director is Responsible: _____

   Child Life Specialist Director: _____

   Key Unit Child Life Specialist(s): _____

   Discipline's role in unit: _____

   _____

   _____

10. Early Childhood Education

    Chief to whom Early Childhood

    Education Director is Responsible: _____

    Education Director: _____

    Key Unit Early Childhood Educator(s): _____

    Discipline's role in unit: _____

    _____

    _____

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11. Parent Council and Representation

Chief to whom Parent Council Organization

and President is Responsible: _____

Parent Council Organization and President: _____

Key Unit Parent Representative(s): _____

Discipline's role in unit: _____

_____

_____

12. Other Discipline(s)

Director/Supervisor: _____

Key Unit Participant(s): _____

Discipline's role in unit: _____

_____

_____

13. State's Lead Agency for Part H, Public Law 99-457 _____

State Director of Part H Services: _____

Key Representative(s): _____

Discipline's role in unit: _____

_____

_____

C. Structural Organization Characteristics

Describe the organization of nursery space and staffing

1. Number of square feet per bedside _____
2. Total number of beds _____
3. Number of intensive care (level III) beds _____
4. Number of intermediate (level II) beds _____

5. Number of care rooms separated by walls with doors _____

6. Total number of nursing staff FTEs _____

7. Total number of nursing staff on payroll _____

8. Average number of per diem nurses _____

9. Number of nurses per nursing role

	# of Individuals in Role
Nursing Director	
Nurse manager	
Nurses in Charge/Assistant Nurses	
Discharge Nurses	
Additional Nurse Specialties (e.g., ECMO)	
Clinical Nurse Specialists	
Staff Nurses	
Nurse Technicians/Aides	
Other Nurses (specify)	
TOTAL	

10. Number of volunteers/month included in patient care and comfort provision (describe role(s) in nursery)

_____

_____

_____

_____

11. Number of medical staff members (M.D.s)/month (including staff members covering nights and weekends): # of Individuals in Role

Attendings	_____
Fellows	_____
Neonatal Nurse Practitioners	_____
Residents	_____
Interns	_____
Medical Students	_____
Other (specify)	_____
TOTAL	_____

12. Number of levels of medical education represented in the unit: # of Individuals in Role

Chief	_____
Attendings	_____
HMO Representatives	_____
Private Pediatricians	_____
Community Physicians	_____
Surgeons	_____
Fellows	_____
Neonatal Nurse Practitioners	_____
Residents	_____
Interns	_____
Medical Students	_____
Other (specify)	_____
TOTAL	_____

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13. Number of medical services overseeing the day to day care in the NICU:

	# of Individuals in Role
In-House Neonatology	
Cardiac Surgery	
General Surgery	
ECMO Service	
Health Plan Neonatologists	
Other (specify)	
TOTAL	

14. Number of different attendings rotating through the unit/year, as documented on rotation schedule, excluding moonlighters (include length of rotation, e.g., monthly, weekly, etc.)

_____

15. Number of other nursery staff members per category:

	# of Individuals in Role
Secretaries	
Clerks	
Respiratory Therapists	
Social Workers	
Physical Therapists	
Occupational Therapists	
Nutritionists	
Lactation Consultants	
Other (specify)	
TOTAL	

D. Developmental Care Support Characteristics

Calculate the number of developmental care-related staff, structures, and materials available to the nursery.

1. Percent of NIDCAP introduced nurses (NIDCAP introduced nurse's hours per week/ total FTE) _____
2. Percent of nursing hours/week of NIDCAP reliable nurses (NIDCAP introduced nurse's hours per week/ total FTE) _____
3. Number of other staff NIDCAP introduced _____
4. Number of other staff NIDCAP reliable _____
5. Number of NIDCAP introduced leadership staff (if also identified in Section B, please specify) _____
6. Number of NIDCAP reliable leadership staff (if also identified in Section B, please specify) _____
7. Number of hours of developmental care nursing orientation _____
8. Number of hours developmental care physician orientation and/or education/month _____
9. Number of individuals with paid time as resource and support professional for developmental care implementation (include discipline and number of hours) _____
10. Number of hours paid or paid time freed up for NIDCAP training and practice for staff beyond orientation _____
11. Number of organizational structures to support developmental care:

	Describe
a. Developmental Committee/Work Groups	
b. Developmental Rounds	
c. Child Care for Siblings of Infants in Unit	
d. Formalized Developmental Education for Medical Staff	

e. Formalized Developmental Consultation _____

f. Policies and Programs in Support of Family Integration (e.g., parent groups, skin-to-skin holding, bereavement groups, breastfeeding supports, etc.) _____

g. Other _____

TOTAL _____

12. Number of developmentally supportive materials introduced unit-wide (check and describe all that apply):

a. Buntings, nests _____

b. Sheepskin _____

c. Isolette covers _____

d. Hammocks _____

e. Bili blanket _____

f. Reclining chairs and beds for families in nursery _____

g. Other _____

TOTAL _____

E. Developmental Care History and Goals

Reflect on past, present , and future directions around incorporation of developmental care in the nursery.

1. Description of Context

Describe your nursery's history with developmental care; who introduced it; how it developed; how you learned of the NIDCAP training program. Outline briefly the sequence of developments; persons and disciplines involved.

2. Site's Observed Strengths and Challenges

a. Nursery Ambiance and Atmosphere

b. Nursery Physical Appearance (describe the parents' path from the hospital entrance to and into the nursery and draw the nursery's floorplan)

c. Comment Briefly on Dynamics of the Following Relationships within the Unit:

Nurse ⇔ Nurse

Physician ⇔ Physician

Physician ⇔ Nurse

Nurse ⇔ Nursing Leadership

Physician ⇔ Physician Leadership

Nurse Leadership ⇔ Physician Leadership

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Nurse ⇔ Other Disciplines _____

Physician ⇔ Other Disciplines _____

d. Overall Assessment of Mutual Support _____

e. Overall Assessment of Nursery Staff's Sensitivity to Interpersonal Dynamics _____

Staff ⇔ Staff _____

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Staff ⇔ Families _____

_____

_____

_____

_____

_____

f. Nursery's Management and Leadership Style _____

_____

_____

_____

_____

_____

g. General Familiarity of Developmental Care Concepts _____

_____

_____

_____

_____

_____

h. Overall Nursery Interest/Commitment for Implementing Developmental Care _____

_____

_____

_____

_____

_____

i. Ongoing Research Projects (Include research interests and disciplines participating in studies)

F. Summary of Site Assessment

Describe the nursery in terms of the following questions.

1. What strengths of your setting do you expect to support the integration of developmental care?

2. What will present the greatest challenges to the implementation of developmental care in your setting?

3. What are the goals for your setting over the next five years (sketch a projected stepwise outline of specific goals)?

4. What difficulties do you anticipate in the course of the path for your setting?

5. What would your setting find most helpful in accomplishing these steps?

6. How are you planning to develop the resources deemed helpful?

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7. List the names of the professionals, including their degrees and titles, to participate in NIDCAP training.

8. How were the professionals chosen for NIDCAP training (e.g., self-selected, assigned; one discipline targeted, multiple disciplines included)?

9. Other comments

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Please return this questionnaire to:

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Trainee Self-Assessment

Preliminary Draft

Heidelise Als, Ph.D.
Harvard Medical School
Children's Hospital
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Introduction

An important component of effective training and functioning in a developmental care model is understanding oneself and the organizational structures supportive of the integration of developmental care. Therefore, it is important to reflect on yourself, explore your already existing skills, and the supports from within the setting; as well as perceptions and supports within and across other disciplines in the NICU.

The following document provides a format for your self assessment. Please, make the information available to the NIDCAP trainer in advance of your first training session. It provides the starting point for joint reflection and assessment of the opportunities for your training, and a base for guidance and timeline development.

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Date: _____

Trainee's Name: _____

Discipline: _____

Position in the Nursery and Hospital: _____

Hospital Name: _____

Hospital Address: _____

_____

_____

Nursery Name(s) : _____

Contact Person(s): _____

Discipline(s) of Contact Person(s): _____

Telephone and Fax Number: _____

Person Filling Out Questionnaire: _____
(if different from trainee above)

Discipline of and Position of
Person filling out questionnaire: _____

TRAINEE SELF-ASSESSMENT

Describe yourself and your goals and objectives for the upcoming training session as well as for the integration of your role as developmental care provider into the nursery.

1. Describe your role in the nursery, include your nursery developmental care implementation responsibilities. _____

_____

_____

_____

_____

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2. What are your plans for the integration into your current role of the skills and education to be acquired in the planned training?

3. What are your expectations and objectives for this training session?

4. What are strengths and skills from your own background that you bring to developmental care implementation and the planned training?

5. What do you expect will be the challenges for you in participating in the training and in implementing developmental care in your setting?

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6. Are there others at your settings who have or will participate in NIDCAP training (describe)?

7. What do you perceive are strengths of the others already trained or planning to be NIDCAP trained?

8. What do you perceive as challenges for the other trainees planning to participate in NIDCAP training?

9. What professional supports do you have for your own training and professional development around issues of developmental care integration?

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10. Who may be available as resource(s) for you for developmental care implementation support?

11. What are your goals around developmental care training and implementation over the next year and over the next five years?

12. What difficulties do you anticipate in the course of the path?

13. What would you find most helpful in accomplishing your goals?

14. What resources do you plan to develop towards overcoming the difficulties you foresee?

15. How did you go about filling out this questionnaire (e.g., on your own, as a group [include staff members involved])?

14. Other comments

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APPENDIX F

PRODUCTS

1. PAPERS
2. ADDITIONAL INSTRUMENTS

APPENDIX F

PAPERS

1. Als H, Lawhon G, Duffy FH, McAnulty GB, Gibes-Grossman R, Blickman JG. Individualized developmental care for the very low birthweight preterm infant: Medical and neurofunctional effects. JAMA 1994; 272:853-858.

2. Buehler DM, Als H, Duffy FH, McAnulty GB, Liederman J. Effectiveness of individualized developmental care for low risk preterm infants: Behavioral and electrophysiological evidence. Pediatrics in press.

3. Gilkerson L, Als H. Role of reflective process in the implementation of developmentally supportive care in the newborn intensive care unit. Infants and Young Children 1995; 7:20-28.

Individualized Developmental Care for the Very Low-Birth-Weight Preterm Infant

Medical and Neurofunctional Effects

Heidelise Als, PhD; Gretchen Lawhon, RN, PhD; Frank H. Duffy, MD; Gloria B. McAnulty, PhD; Rita Gibes-Grossman, RN, MS; Johan G. Blickman, MD

Objective.—To investigate the effectiveness of individualized developmental care in reducing medical and neurodevelopmental sequelae for very low-birth-weight infants.

Design.—Randomized controlled trial.

Setting.—Newborn intensive care unit.

Patients.—Thirty-eight singleton preterm infants, free of known congenital abnormalities, weighing less than 1250 g, born before 30 weeks' gestation, mechanically ventilated within 3 hours of delivery and for more than 24 hours in the first 48 hours, randomly assigned to a control or an experimental group.

Intervention.—Caregiving by nurses specifically trained in individualized developmental care; observation and documentation of the infants' behavior within 12 hours of admission, and subsequently every 10th day; developmental care recommendations and ongoing clinical support for the nurses and parents based on regular observation of the infant by developmental specialists; and the availability of special caregiving accessories.

Main Outcome Measures.—Medical outcome, including average daily weight gain; number of days the infant required mechanical ventilation, oxygen, gavage tube feeding, and hospitalization; severity of retinopathy of prematurity, bronchopulmonary dysplasia, pneumothorax, and intraventricular hemorrhage; pediatric complications; age at discharge; and hospital charges. Neurodevelopmental outcome, including Assessment of Preterm Infants' Behavior scale and quantified electroencephalography (2 weeks after due date); and Bayley Scales of Infant Development and Kangaroo Box Paradigm (9 months after due date).

Results.—The infants in the experimental group had a significantly shorter duration of mechanical ventilation and supplemental oxygen support; earlier oral feeding; reduced incidence of intraventricular hemorrhage, pneumothorax, and severe bronchopulmonary dysplasia; improved daily weight gain; shorter hospital stays; younger ages at hospital discharge; and reduced hospital charges compared with the infants in the control group. At 2 weeks after their due dates, these infants also showed improved autonomic regulation, motor system functioning, self-regulatory abilities, and visual evoked potential measures; and at 9 months, they had improved Bayley Mental and Psychomotor Developmental Index scores, as well as Kangaroo Box Paradigm scores.

Conclusion.—Very low-birth-weight preterm infants may benefit from individualized developmental care in the neonatal intensive care unit in terms of medical and neurodevelopmental outcome.

(*JAMA* 1994;272:853-858)

VERY LOW-BIRTH-WEIGHT infants who need mechanical ventilation are at high risk for bronchopulmonary dysplasia (BPD), intraventricular hemorrhage (IVH), and retinopathy of prematurity. These conditions are frequently associated with long-term pulmonary, neurological, cognitive, behavioral, and emotional compromise. They produce high costs in newborn intensive care and ambulatory care after discharge.[1] Reducing such costs is a top priority for current neonatal intensive care.

Current neonatal intensive care unit (NICU) environments, with their constant noise, lights, and procedures, have been found to influence infants' arterial oxygen saturations directly and contribute to the development of chronic lung disease.[2] Concerns have also been raised that unexpected activation of the premature infant's immature brain, as occurs in the NICU environment, may inhibit developing neuronal pathways and interfere with full differentiation.[3]

For editorial comment see p 890.

Changing the NICU environment to reduce stress to the infant may help improve these outcomes.[4] An approach to intensive care has been developed that is geared to support the individual infant's own efforts toward self-regulation and competent functioning. Since even very immature infants display reliably observable behaviors in the form of autonomic and visceral responses, movement patterns, postures, tone fluctuation, and levels of awakeness,[4,5] repeated systematic observation of the infants' behavior before, during, and after provision of care is used to identify the infants' current behavioral goals, strengths, and vulnerabilities. Trained staff then deliver care in a way that makes use of and enhances the infants'

From the Department of Psychiatry (Dr Als), Department of Neurology (Drs Duffy and McAnulty), and Department of Radiology (Dr Blickman), Harvard Medical School, and the Department of Nursing, Brigham and Women's Hospital (Dr Lawhon and Ms Gibes-Grossman), Boston, Mass.

Dr Als holds a patent for the bunting, one of the special caregiving accessories available for the infants in the experimental group. She has a royalty arrangement with the manufacturer and a contract with the corporation for profit sharing.

Reprint requests to Enders Pediatric Research Laboratories, EN-029, Children's Hospital, 320 Longwood Ave, Boston, MA 02115 (Dr Als).

specific strengths and diminishes their vulnerabilities. The approach is referred to as individualized, developmentally focused intensive care[6] and is increasingly advocated clinically. So far, however, only two investigations have tested its effectiveness. Both used phase-lag historical designs.[7,8] The purpose of the current study was to test the impact of individualized developmental care, with the use of a more rigorous design with random assignment and initiation of the intervention at the time of admission.

PATIENTS AND METHODS

The study was conducted at the Brigham and Women's Hospital in Boston, Mass, in a 46-bed, level III NICU, with a 98% inborn population, and with primary care nursing.

Patients

The study population was derived from a group of 43 eligible infants consecutively admitted in a 21-month period, who met the following criteria: (1) inborn; (2) birth weight less than 1250 g; (3) less than 30 weeks and more than 24 weeks of estimated gestational age at birth[9]; (4) mechanical ventilation starting within the first 3 hours after birth and (5) lasting longer than 24 hours in the first 48 hours; (6) alive at 48 hours; (7) absence of chromosomal or other major genetic anomalies, congenital infections, and known fetal exposure to drugs of addiction; (8) singleton; (9) at least one family member with some English-language facility; (10) telephone access; and (11) living within the greater Boston area.

On admission to the NICU, infants were screened for meeting selection criteria 1 through 4 and 7 through 11. Informed consent was obtained in accordance with the study hospital's guidelines. Group status was determined by means of a sealed-envelope random assignment procedure. Experimental primary care teams were assigned to the care of infants in the experimental group within 3 hours. Control group status was not revealed to staff, nor was staffing for infants in the control group influenced in any way. Four infants were judged not viable by the admitting physician; all four of these died. One family refused participation.

Experimental Intervention

The experimental treatment consisted of staffing by specially educated nurses; regular evaluation of the infants' behavior with suggestions for ways to support their development, performed by a developmental psychologist (H.A.) and/or a developmentally trained clinical nurse specialist (G.L.); and the availability of special caregiving accessories.

Forty of 160 nurses volunteered for education in developmental care. This education was conducted by the psychologist and the nurse specialist before the start of the experimental component of the project. It was geared to bring about a shift from protocol-dependent to strategic thinking, with focus on the recognition of infants as being competent and as actively participating in their own care and shaping their own development. Extensive training[5,6] in the systematic observation of each infant's unique repertoire of behaviors, and in the understanding of the opportunities these behaviors offer for care provision, constituted the core of this education, as described elsewhere.[5] For the infants in the experimental group, at least one shift in a 24-hour cycle from admission on was staffed by a nurse specifically educated in this approach.

The psychologist and clinical nurse specialist provided ongoing support for the care teams and parents of the infants in the experimental group in jointly planning and implementing individually supportive care and environments. To this end, they conducted formal observations of each infant's behavior, starting during the acute phase of initial stabilization within 12 hours of admission, and subsequently every 10th day until hospital discharge. For each observation, the infants' responses were systematically recorded for approximately 20 minutes before a necessary medical or nursing caregiving activity, throughout the duration of the caregiving, and for approximately 20 minutes after the caregiving activity.

Ninety-one behaviors, including autonomic (respiration, heart rate, color changes, visceral signs), motor (postures, muscle tone fluctuations, movements), and state organization behaviors (levels of arousal, patterns of transitions between states, clarity and robustness of sleep and awake states), were monitored every 2 minutes.[5,7] Interrater reliability was established at greater than 85% accuracy. Behaviors were conceptualized as stress (eg, flaccidity, agitated or frantic movements, hyperextensions, duskiness, respiratory pauses, gagging, spitting up, finger splaying, arching, gaze aversion) and regulatory behaviors (eg, hand to mouth, hand clasping, grasping, efforts to suck, tucking) and interpreted as indexes of the infants' current vulnerabilities and strengths, respectively.

The observations were then used to formulate descriptive neurobehavioral reports, including specific suggestions for ways to promote the infants' stability and competence in regulating themselves. Suggestions included, for instance, gently placing the infant in a flexed position to promote restfulness; encouraging supportive holding during and after procedures and taxing manipulations; structuring sleep and feeding in synchronization with the infant's sleep and wake cycles; instituting dark and quietness; and, from admission on, supporting the parents in assisting as well as in nurturing and caring for their infants. Several accessories specifically designed to support the experimental group infants could be used as indicated, including a terry cloth bunting, a hammock, and a soft nipple sewn into a long, soft terry cloth band. The behavioral reports were used by the parents and primary care teams, with support by the psychologist and nurse specialist, to formulate specific individualized developmental care plans for the infants in the experimental group.

Control Group Treatment

Control group infants received the standard care practiced throughout the Brigham and Women's Hospital NICU. This included primary care nursing and a standard developmental protocol, involving uniform shielding of incubators with blanket covers, use of clothing, as well as a 24-hour visiting policy for the parents.

Background and Outcome Assessment

The effectiveness of the individualized, developmentally based approach to intensive care was assessed in terms of medical and developmental outcome at 2 weeks and 9 months after the expected date of confinement (EDC). After discharge, the infants' medical records, after removal of the neurobehavioral reports, were reviewed by trained research staff who were unaware of the group status of the infants and the goals of the study. Medical background variables assessed included birth weight; gestational age at birth[9]; Apgar scores[10] at 1 and 5 minutes; mean and maximum levels of fractions of inspired oxygen in the first 48 hours and first 10 days; the presence of patent ductus arteriosus; mode of delivery; obstetric complications[11]; and antenatal corticosteroid treatment, all known to influence outcome. Demographic background variables included maternal age, social class,[12] marital status, child's gender, birth order, and ethnic background. The interaction of gender and ethnic background with the mean and maximum levels of fraction of inspired oxygen in the first 48 hours and to day 10, and with patent ductus arteriosus, were also assessed.

Medical outcome variables included days of mechanical ventilator support, re-

Table 1.—Medical and Demographic Background Variables*

Variable	Control Group (n=18)	Experimental Group (n=20)	df	F	χ^2	P
Birth weight, g	862±145	872±173	1, 36	0.04		.85
Gestational age at birth, wk	26.5±1.4	27.1±1.6	1, 36	1.90		.18
Apgar score						
1 min	2.9±1.7	3.8±2.3	1, 36	1.88		.18
5 min	5.5±1.8	5.6±2.5	1, 36	0.02		.89
Fraction of inspired oxygen						
1st 48 h						
Mean	0.55±0.19	0.48±0.17	1, 36	1.20		.28
Maximum	0.85±0.23	0.80±0.24	1, 36	0.42		.52
Day 1-day 10						
Mean	0.38±0.11	0.33±0.08	1, 36	2.77		.11
Maximum	0.86±0.22	0.81±0.24	1, 36	0.39		.53
Maternal age, y	28.33±5.18	27.65±5.63	1, 36	0.15		.70
Obstetric Complications Scale scores (mean, 100, SD, 20)	58.72±11.45	59.10±11.85	1, 36	0.01		.92
Patent ductus arteriosus, No. yes/no	9/9	8/12	1		0.38	.54
Prenatal corticosteroids, No. yes/no	1/17	3/17	1		0.90	.34
Parents married or attached, No. yes/no	16/2	18/2	1		0.01	.91
No. firstborn/later born	9/9	9/11	1		0.10	.76
Sex, No. M/F	11/7	9/11	1		0.99	.32
Race, No. black/other	3/15	8/12	1		2.51	.11
Race of female infants, No. black/other	2/5	4/7	1		0.12	.73
Vaginal deliveries, No. yes/no	7/11	7/13	1		0.06	.80
Social class, No. I and II/III/IV and V	10/3/5	9/4/7	2		0.43	.81

*Results are mean±SD except as otherwise stated. One-way analysis of variance: F, two tailed; χ^2 test, two tailed.

Table 2.—Medical Outcome Variables*

Variable	Control Group (n=18)	Experimental Group (n=20)	df	F	χ^2	P
Average daily weight gain from birth to 2 wk after EDC, g	20±6	24±7	1, 36	3.18		.08
Age after LMP at discharge, wk	48.3±17.3	39.7±3.1	1, 18	4.27		.05
No. of days in hospital	151±120	87±26	1, 18	4.78		.04
No. of days of mechanical ventilation	63.8±72.9	28.3±23.3	1, 20	3.93		.06
No. of days of oxygen	139.4±166.1	56.8±39.3	1, 19	4.25		.05
No. of days before bottle feeding	104.1±85.8	59.2±25.8	1, 18	4.33		.05
Pediatric Complications Scale scores (mean, 100, SD, 20)	53.1±2.5	55.5±4.4	1, 31	4.43		.04
Hospital charges, $1000s	189±174	98±37	1, 18	4.72		.04
Retinopathy of prematurity, No.						
None	5	10	2		1.99	.37
Mild (stages I and II)	10	8				
Moderate (stage III)	3	2				
Severe (stages IV and V)	0	0				
Bronchopulmonary dysplasia, No.						
None	3	2	3		9.21	.03
Mild (stage I)	7	13				
Moderate (stage II)	2	5				
Severe (stage III)	6	0				
Pneumothorax, No.						
No	12	19	3		6.49	.09
Mild	1	1				
Moderate	3	0				
Severe	2	0				
Intraventricular hemorrhage, No.						
None	8	19	4		12.75	.01
Grade I	3	0				
Grade II	1	0				
Grade III	2	1				
Grade IV	4	0				

*Results are mean±SD except as otherwise stated. Brown-Forsythe one-way analysis of variance: F, two tailed; χ^2, two tailed. EDC indicates expected date of confinement; LMP, last menstrual period.

endotracheal intubation; days of oxygen therapy; incidence and severity of pneumothorax and of BPD assessed by double-blind review of chest roentgenograms (J.G.B.),[11] of IVH assessed by double-blind review of cranial ultrasound scans by a consultant senior radiologist,[14] and of retinopathy of prematurity assessed by the NICU pediatric ophthalmologist[15]; days of intravenous and gavage tube feeding; average daily weight gain to 2 weeks after EDC; gestational age at discharge; number of days of hospital stay; pediatric complications[16]; and hospital charges from admission to discharge. Developmental outcome evaluation included, at 2 weeks after EDC, the Assessment of Preterm Infants' Behavior (APIB) using the 32 standard a priori variables,[4] as well as quantified electroencephalography and evoked potentials with topographic mapping.[1] At 9 months after EDC, it included the Bayley Scales of Infant Development[17] and a videotaped 15-minute play observation (Kangaroo Box Paradigm).[18] Weight, height, and head circumference were measured at both age points. All developmental outcome assessments were conducted at the Enders Pediatric Research Laboratories, Children's Hospital, Boston, Mass, by trained examiners not familiar with the goals of the study or the group membership of the infants.

Analyses

At a probability level of <.05, two tailed, the sample size chosen ensures the detection of medium to large effects accounting for between 23% and 69% of the variance.[19] For those outcome variables that showed significant group differences in terms of variance, instead of the one-way analysis of variance test (F), the conservative Brown-Forsythe Equality of Means Test (F^*)[20,21] was used, which does not assume equivalence of variances between groups. For categorical variables, the χ^2 test with Yates' correction was used. Canonical correlation analysis,[22] which defines covariation for two groups of variables, was performed to test the relationship of the behavioral findings from the newborn to 9-month testing. Path analysis[23,24] was used to investigate the influence of IVH and BPD on the other significant outcome findings. The technique was used as a way of describing partial associations within the structure of the data. It does not imply completeness of the model.

RESULTS

None of the background measures showed significant differences (Table 1), nor did any of the interactions tested, supporting the assumption of comparability of the control and experimental groups on admission to the study.

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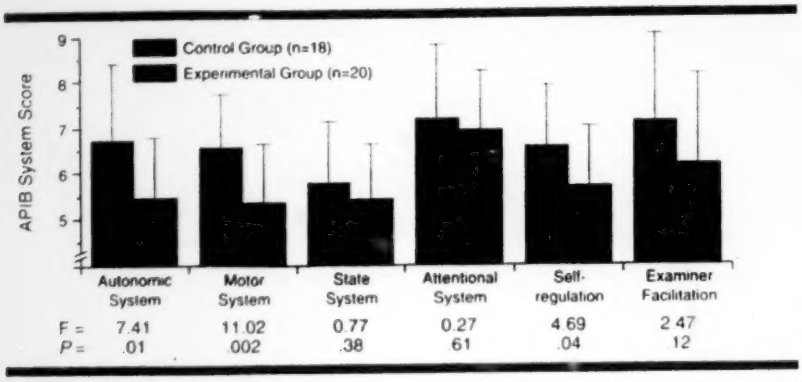

Figure 1.—Assessment of Preterm Infants' Behavior (APIB) system scores 2 weeks after expected date of confinement (mean±SD). Higher scores represent more poorly organized performance. Scores for autonomic, motor, state, and self-regulation systems are based on 18 scores per infant, for the attentional system, three scores, and for examiner facilitation, six scores. Significant F scores for the autonomic, motor, and self-regulation systems indicate that infants in the experimental group had better functioning of these systems.

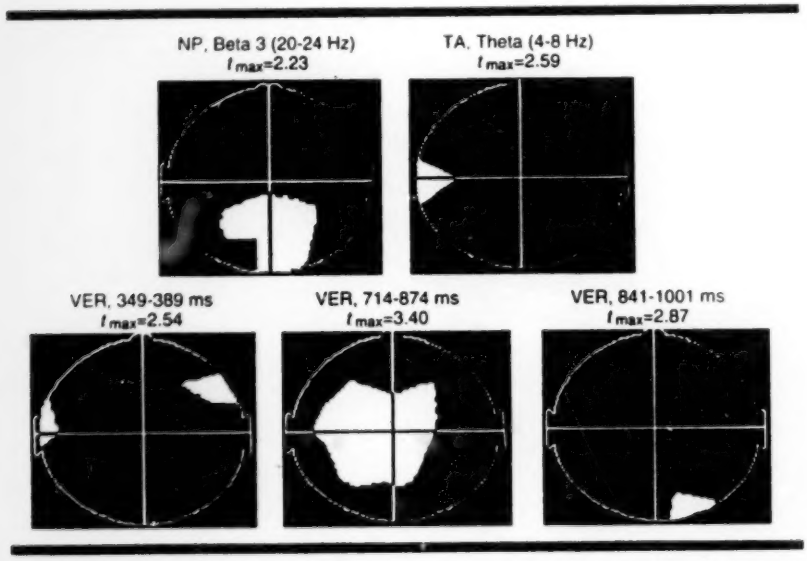

Figure 2.—Electrophysiological group differences 2 weeks after expected date of confinement. Schematic outlines show the nose at the top, the left ear to the left, and the right ear to the right. The white areas represent regions of significant between-group differences ($P<.05$, two tailed). The state of brain activation and the maximum t value (t_{max}) are as follows: nonprocessing awake (NP), in the electroencephalographic beta 3 range of 20 to 24 Hz; tracé alternant (TA), or quiet sleep, in the electroencephalographic theta range of 4 to 8 Hz; and visual-evoked response (VER) in quiet sleep from the times indicated. There were 14 infants in the control group and 17 in the experimental group.

Medical Outcome

Of the 12 medical outcome variables, eight were statistically significantly different, favoring the experimental group (Table 2). Although severity of lung disease and incidence of pneumothorax were significantly lower for the experimental group, there was no significant correlation between them ($r=.17$; $P>.50$). The earliest pneumothorax occurred on day 3 and the latest on day 21, ie, all well beyond the time of treatment onset for the experimental group.

Significantly more infants in the control group developed IVH, again after the time of treatment onset for the experimental group. Of the 10 infants in the control group with IVH, eight had normal ultrasound studies of the head on days 1 and/or 2, with the day of birth counted as day 0. One infant had a questionable grade II IVH on the first ultrasound performed on day 1, and one had a grade IV IVH by day 2, when the first ultrasound was performed. The one infant in the experimental group with IVH showed a grade II IVH on the first ultrasound performed on day 1, which developed into a grade III IVH by day 2. Although IVH was significantly more common in the control group, the correlation of IVH with severity of lung disease ($r=-.009$; $P>.50$) was not significant. Thus, the experimental group appeared to show an independent reduction in lung and in brain morbidity.

Developmental Outcome

Age at developmental outcome assessment was similar for the two groups at both outcome points (mean±SD, 18±5 vs 16±4 days after EDC and 9.2±0.6 vs 9.4±0.5 months after EDC). Growth variables measured did not show group differences at either outcome point. However, at 2 weeks after EDC, three of the six APIB system scores, ie, more than expected by chance, were significantly different, all favoring the infants in the experimental group. Figure 1 shows the APIB system score comparisons. Infants in the experimental group were better modulated in autonomic and motor system regulation, as well as in self-regulation. Furthermore, four of the 18 APIB summary variables[25]—symmetry of orientation ($P<.003$), autonomic stability ($P<.0002$), modulation of tone, movement, and posture ($P<.03$), and symmetry of motor performance ($P<.02$)—showed differences, favoring the experimental group, which also showed a significantly lower number of abnormal reflexes ($P<.002$) as assessed on the APIB.

Results of the neuroelectrophysiological evaluation in the brain activation states of alert processing, awake and not processing, quiet sleep, and flash visual-evoked response during quiet sleep for 14 infants in the control group and 17 in the experimental group identified five regions of significant differences between groups (Figure 2). These involved the parieto-occipital regions, the left midtemporal region, the right frontal and occipital regions, and a large bilateral central region. Two-group stepwise discriminant function analysis entering all five variables numerically representing the regions depicted yielded a Wilks' Λ of 0.476 ($P<.0003$), implying a large difference between the groups. Classification was 83.9% successful.

By 9 months after EDC, two infants in the control group were unavailable for study. On assessment with the Bayley Scales of Infant Development, the experimental group compared with the control group showed a significantly higher Mental Developmental Index (118.30±17.35 vs 94.38±23.31; $F=12.47$; $df=1, 34$; $P\leq.001$) and Psychomotor Developmental Index (100.60±20.19 vs 83.56±17.97; $F=6.97$; $df=1, 34$; $P\leq.01$).

Furthermore, of 20 infant variables measured in the 6-minute Kangaroo Box Paradigm Play Episode, 17 showed differences favoring the experimental group. They ranged in significance level

from <.03 to <.0001. The largest differences were found in gross and fine motor modulation, overflow postures and associated movements, complexity and modulation of combining object and social play, ability to stay engaged in the task, and degree of facilitation necessary. In the 6-minute Stillface Episode, 12 of 19 infant variables showed significant group differences ($P<.04$ to $<.0001$), again favoring the experimental group. None of the 14 parent variables assessed showed a significant group difference, yet three interaction variables (turntaking, overall synchrony of the interaction, and overall quality of the interaction [all $P<.0004$]) favored the experimental group. Thus, the infants in the experimental group appeared significantly more well organized, well differentiated, and well modulated than the infants in the control group. Canonical correlation between the factors derived from the APIB variables and the factors derived from the Kangaroo Box variables was significant (canonical $r=.84367$; $\chi^2=50.77$; $df=20$; $P<.0002$). This indicates a strong relationship between overall behavioral regulation at 2 weeks, as measured with the APIB, and overall regulation at 9 months, as measured with the Kangaroo Box Paradigm.

Influence of IVH and BPD

Neither IVH nor BPD had significant indirect effects on any of the medical outcome variables (Table 3). In terms of electrophysiological outcome, IVH had a significant indirect effect on only one variable. However, the direct intervention effect was stronger. The presence of BPD had no indirect effect on any of the electrophysiological findings. Neither IVH nor BPD had any significant indirect effects on any of the APIB or Bayley outcome measures. Furthermore, only two of the 32 Kangaroo Box measures showed significant indirect IVH effects, and none showed indirect BPD effects. Thus, the direct effects of the intervention appeared to go beyond the indirect contribution from reduction in IVH and BPD on the other outcomes.

Table 3.—Path Analysis to Medical, Electrophysiologic, and Behavioral Outcome Measures via IVH and BPD*

Variable	Direct Effect (P_{14})	Indirect Effect IVH ($P_{24}\times P_{12}$)	Indirect Effect BPD ($P_{34}\times P_{13}$)	r
Medical outcome measures (n=38)				
Age after LMP at discharge	0.32†	0.12	0.14	.34†
No. of days in hospital	-0.32†	0.11	0.15	-.36†
No. of days of oxygen	-0.31†	0.13	0.16	-.34†
No. of days before bottle feeding	0.27	0.06	-0.14	.35†
Pediatric Complications Scale scores	0.24	0.02	0.07	.32
Hospital charges	0.27	0.07	0.16	.36†
Electrophysiological outcome (n=31)				
Awake nonprocessing, beta 3 (20-24 Hz)	0.18	0.23	0.01	.41†
Quiet sleep, theta (4-8 Hz)	-0.28	0.16	0.01	-.44†
VER				
From 349-389 ms	0.25	0.19	0.00	.44†
From 714-874 ms	0.32†	0.29†	0.01	.61‡
From 841-1001 ms	0.15	0.30	-0.00	.44†
Behavioral outcome, APIB (n=38)				
Autonomic system	-0.31†	0.01	-0.12	-.41†
Motor system	0.45†	0.02	-0.05	-.48§
Self-regulation system	-0.36.	0.07	-0.05	-.34†
Symmetry of orientation	0.53§	-0.02	-0.02	.49§
Autonomic stability	0.36†	0.00	0.13	.48§
Modulation of tone, movement, and posture	0.19	0.06	0.10	.35†
Symmetry of motor performance	0.38	0.03	-0.03	.39†
No. of abnormal reflexes	-0.50§	0.09	-0.07	-.49§
Behavioral outcome, Bayley Scales (n=36)				
Mental Developmental Index	0.41†	0.04	0.08	.52§
Psychomotor Developmental Index	0.24	0.07	0.10	.41†

*The path analysis tests the relationship of the independent variable, namely, the experimental treatment, to each of the dependent variables, namely, the outcome variables, taking the two intervening variables, intraventricular hemorrhage (IVH) and bronchopulmonary dysplasia (BPD), into account. The direct effect (P_{14}) and the two indirect effects ($P_{24}\times P_{12}$ and $P_{34}\times P_{13}$) sum to yield Pearson product moment correlations (r) between the experimental treatment and the outcome variables. LMP indicates last menstrual period; VER, visual-evoked response; and APIB, Assessment of Preterm Infants' Behavior.

†$P\leq .05$, two tailed.

‡$P\leq .005$, two tailed.

§$P\leq .01$, two tailed.

COMMENT

This study shows significant effects of a developmentally based, individualized approach to newborn intensive care, in terms of improved medical status and developmental outcome. Chance cannot account for the findings, since the number of effects was significantly larger than would be expected.[19] The pattern of the results was orderly and in keeping with the theory underlying the approach tested, which sees infants in the NICU as actively seeking behavioral support of their initial stabilization, ongoing differentiation, and developmental progression. Support to the infants' behavioral organizational efforts and competencies from the initial acute phase on may yield calmer infants, resulting in reduced cerebral blood flow velocity changes and fewer IVHs.[26] Since eight of 10 IVHs in the control group definitely occurred after the onset of the study, only two may potentially have occurred in utero, as did possibly the one IVH in the experimental group.[27] When these three instances of possibly intrauterine hemorrhages were excluded, the difference in incidence between the two groups was still significant ($P<.002$). Calmer infants also may require less supplemental oxygen and therewith develop less severe lung disease. This is in keeping with accepted mechanisms of lung disease.[28] The relatively low overall incidence of retinopathy of prematurity in both groups may in part be attributable to the covering of incubators in the study nursery for all infants,[29] and perhaps the closer attention to oxygenation levels.

Given the reduction in severity of lung disease and in incidence of IVHs, one would expect better neurobehavioral outcomes. The reduction in IVH did indeed contribute to some extent to improved neurobehavioral functioning and especially to improved neuroelectrophysiological functioning. The large bilateral central region found in the control group on the quantified electroencephalogram is consistent with data from positron emission tomographic studies,[30] suggesting broad regions of hypometabolism associated with extensive IVH. Yet a large number of outcome differences do not appear to be attributable to increased IVH and BPD in the control group, as the lack of correlation between IVH and BPD and the results of the path analysis showed. In fact, of the six infants in the control group with severe IVH (grade III and IV), only one showed severe chronic lung disease. Of the other five infants with severe BPD, three had no IVH and two had a grade I IVH only. The direct effect of the intervention may in part be associated with a reduction in progressive central nervous system injury from chronic hypoxemia[31] or might also reflect differences in sensory environmental experience,[1] leading to im-

proved brain development and neurobehavioral functioning. The strong correlation of improved neuroregulation in the newborn period and at 9 months appears to support the postulation of improved brain development.

Despite the encouraging results of this study, caution in interpretation is nevertheless indicated for several reasons. Although none of the background measures available showed significant group differences, other measures of initial severity of respiratory illness, such as mean airway pressure, will need to be evaluated in a future study. Furthermore, one might want to evaluate the developmental approach for a very low-birth-weight population treated with surfactant,[32] although to date, no significant surfactant effects on health and development at 1 and 2 years of age have been reported.[33]

A further factor to be considered in interpreting the results of this study is the possible differential skill, maturity, previous NICU experience, and motivation of the nursing staff who volunteered for developmental education, which might have accounted for the improved outcome in the intervention group. However, the nurses who volunteered were significantly younger (29.4±3.5 vs 32.3±4.5 years; $P<.002$) and had fewer years of NICU experience (4.7±3 vs 7.1±4.3 years; $P<.005$). Motivation is harder to measure. It will be important to study the success of developmental education for staff who are required to obtain such education, rather than who volunteer to do so. Since the study was conducted in one unit, it is probable that spillover of developmental care principles to control infants occurred. This is not of concern, however, since it would work against finding an effect.

A possible confounding factor on outcome at 9 months might be the effect of early intervention after hospital discharge. However, there was no difference in the number of infants in the control group who received early intervention after discharge compared with infants in the experimental group (14 of 16 vs 11 of 20; $P<.08$). Although information on outcome beyond 9 months is not available at this point, other studies have indicated predictive validity of the APIB and Kangaroo Box Paradigm assessments to ages 5 and 8 years.[34,35]

In summary, this highly controlled, randomized trial suggests that for very low-birth-weight, initially very ill, and early born infants, individualized, developmentally based intensive care improves outcomes medically and developmentally. The results validate and extend the findings of initial studies. Provision of expert intensive medical care within an individualized, developmental framework is not only feasible but necessary to enhance the effectiveness of NICU care.

This study was supported by the National Institute on Disability and Rehabilitation Research, the Early Education Programs for Children With Disabilities, Office of Special Education Programs, US Department of Education; the Merck Family Fund; and the National Institutes of Health.

The authors thank the parents and infants for their participation, the study nurses for their collaboration, and the medical and nursing staff for their support. The authors are indebted to Kenneth Jones, EdD, for statistical consultation, Peter M. Doubilet, MD, PhD, for radiology consultation, Richard Parad, MD, for neonatology consultation and critical review of the manuscript, and Geoffrey Love and Michael Ferguson for manuscript preparation.

References

1. McCormick MC. Advances in neonatal intensive care technology and their possible impact on the development of low birthweight infants. In: Friedman SL, Sigman MD, eds. *Advances in Applied Developmental Psychology, Vol 6: The Psychological Development of Low-Birthweight Children*. Norwood, NJ: Ablex Publishing Co; 1992:37-60.
2. Als H. Individualized, family-focused developmental care for the very low birthweight preterm infant in the NICU. In: Friedman SL, Sigman MD, eds. *Advances in Applied Developmental Psychology, Vol 6: The Psychological Development of Low-Birthweight Children*. Norwood, NJ: Ablex Publishing Co; 1992:341-388.
3. Duffy FH, Als H, McAnulty GB. Behavioral and electrophysiological evidence for gestational age effects in healthy preterm and fullterm infants studied two weeks after expected due date. *Child Dev* 1990;61:1271-1286.
4. Als H, Lester BM, Tronick EZ, Brazelton TB. Manual for the assessment of preterm infants' behavior (APIB). In: Fitzgerald HE, Lester BM, Yogman MW, eds. *Theory and Research in Behavioral Pediatrics*. New York, NY: Plenum Press; 1982;1:65-132.
5. Als H. *A Manual for the Naturalistic Observation of the Newborn (Preterm and Fullterm)* [photocopy], revised. Boston, Mass: Dept of Psychiatry, Harvard Medical School; 1984.
6. Als H, Gibes R. *Newborn Individualized Developmental Care and Assessment Program (NIDCAP): Training Guide* [photocopy]. Boston, Mass: Dept of Psychiatry, Children's Hospital; 1986.
7. Als H, Lawhon G, Brown E, et al. Individualized behavioral and environmental care for the very low-birth-weight preterm infant at high risk for bronchopulmonary dysplasia: neonatal intensive care unit and developmental outcome. *Pediatrics* 1986;78:1123-1132.
8. Becker PT, Grunwald PC, Moorman J, Stuhr S. Outcomes of developmentally supportive nursing care for very low-birth-weight infants. *Nurs Res* 1991;40:150-155.
9. Ballard JL. A simplified assessment of gestational age. *Pediatr Res* 1977;11:374.
10. Apgar V. A proposal for a new method of evaluation of the newborn infant. *Anesth Analg* 1953; 32:260-267.
11. Littman B, Parmelee AH. *Manual for Obstetric Complications* [photocopy]. Los Angeles, Calif: Infant Studies Project, Dept of Pediatrics, School of Medicine, UCLA; 1974.
12. Hollingshead AB. *Four Factor Index of Social Status*. New Haven, Conn: Yale University; 1975.
13. Northway WH. Observations on bronchopulmonary dysplasia. *J Pediatr* 1979;95:815-818.
14. Kuban K, Teele RL. Rationale for grading intracranial hemorrhage in premature infants. *Pediatrics* 1984;74:358-363.
15. Garner A. An international classification of retinopathy of prematurity. *Pediatrics* 1984;74:127-133.
16. Littman B, Parmelee AH. *Manual for Pediatric Complications* [photocopy]. Los Angeles, Calif: Infant Studies Project, Dept of Pediatrics, School of Medicine, UCLA; 1974.
17. Bayley N. *Bayley Scales of Infant Development*. New York, NY: Psychological Corp; 1969.
18. Als H, Berger A. *Manual and Scoring System for the Assessment of Infants' Behavior Kangaroo-Box Paradigm* [photocopy]. Boston, Mass: Dept of Psychiatry, Harvard Medical School; 1986.
19. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Orlando, Fla: Academic Press; 1969.
20. Brown MB, Forsythe AB. The small sample behavior of some statistics which test the equality of several means. *Technometrics* 1974;16:129-132.
21. Brown MB, Forsythe AB. Robust tests for the equality of variances. *J Am Stat Assoc* 1974;69: 364-367.
22. Cooley WW, Lohnes PR. *Multivariate Data Analysis*. New York, NY: John Wiley & Sons Inc; 1971.
23. Duncan OD. Path analysis: sociological examples. *Am J Sociol* 1966;72:1-16.
24. Wright S. Path coefficients and path regressions: alternative or complementary concepts? *Biometrics* 1960;16:189-202.
25. Als H. *A P I B Features: Summary Variables* [photocopy], revised. Boston, Mass: Dept of Psychiatry, Harvard Medical School; 1987.
26. Volpe JJ. Intraventricular hemorrhage in the premature infant: current concepts, part I. *Ann Neurol* 1989;25:3-11.
27. Paneth N, Pinto-Martin J. The epidemiology of germinal matrix/intraventricular hemorrhage. In: Kiely M, ed. *Reproductive and Perinatal Epidemiology*. Boca Raton, Fla: CRC Press; 1991:371-399.
28. Parad RB, Wohl MEB. Bronchopulmonary dysplasia. *Curr Opin Pediatr* 1990;2:459-464.
29. Glass P, Avery GB, Kolinjavadi N, et al. Effect of bright light in the hospital nursery on the incidence of retinopathy of prematurity. *N Engl J Med* 1985;313:401-404.
30. Volpe JJ, Herscovitch P, Perlman JM, Raichle M. Positron emission tomography in the newborn: extensive impairment of regional cerebral blood flow with intraventricular hemorrhage and hemorrhagic intracerebral involvement. *Pediatrics* 1983; 72:589-601.
31. Perlman JM, Volpe JJ. Movement disorder of premature infants with severe bronchopulmonary dysplasia: a new syndrome. *Pediatrics* 1989;84:215-218.
32. Merritt TA, Hallman M. Surfactant replacement. *AJDC* 1988;142:1333-1339.
33. Ware J, Taeusch W, Soll RF, McCormick MC. Health and developmental outcomes of a surfactant controlled trial: follow-up at 2 years. *Pediatrics* 1990;85:1103-1107.
34. Als H, Duffy FH, McAnulty G, Badian N. Continuity of neurobehavioral functioning in preterm and full term newborns. In: Bornstein MH, Krasnegor NA, eds. *Stability and Continuity in Mental Development*. Hillsdale, NJ: Lawrence Erlbaum Assoc; 1989:3-28.
35. Als H, Duffy FH, McAnulty GB. Neurobehavioral regulation disorder of prematurity. *Infant Behav Dev* 1990;13:159.

Effectiveness of Individualized Developmental Care for Low Risk Preterm Infants: Behavioral and Electrophysiological Evidence

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Pediatrics, in press.

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Of the 3.7 million live births in the U.S. annually, approximately 400,000 (10.8%) are low birthweight (LBW: <2500 grams). By far, the largest and most rapidly growing segment of this population are infants born between 30 and 35 weeks post mother's last menstrual period (LMP).[1] These infants, who are often spared the more severe complications of extreme prematurity, such as chronic lung disease and intraventricular hemorrhage, nevertheless show a high incidence of unexpectedly reduced intelligence quotients, specific learning disabilities, attention deficit disorder, distractibility, impulsivity, language comprehension and speech problems, visual motor impairments, spatial processing disturbances, and emotional difficulties.[2,3,4,5,6,7]

It has been suggested that the premature experience of an extrauterine environment at a time of rapid brain development, may alter brain differentiation and influence later development.[8,9] Animal studies of neuronal development during critical periods support such a hypothesis.[10,11,12,13,14,15,16,17]

The following study was undertaken to investigate whether an individualized approach to caregiving, which modifies the extrauterine environment for the healthy preterm infant while in the hospital will positively influence developmental outcome. This approach has proven effective for the care of medically high risk infants not only in the reduction of intraventricular hemorrhage, need for mechanical ventilation, and severity of chronic lung disease, but also in improvement of neurodevelopmental outcome.[18,19] However, it has never been tested with a preterm population not at risk for such insults.

METHODS

Sample

Two groups of healthy newborns were assessed: (1) infants born at term who experienced the normal intrauterine environment for nine months and who were chosen as a fullterm comparison group; and (2) infants born prematurely, who were cared for in a special care

Care Procedures

The individualized intervention for the preterm experimental group consisted of regular evaluations of the infants' behavior with suggestions for ways to support their development, performed by a developmental psychologist (D.B.) and/or a developmentally trained nurse specialist, and the availability of special caregiving accessories.

The psychologist and developmental nurse specialist provided ongoing support for the care teams and parents of the experimental group infants in jointly planning and implementing individually-supportive care. The focus of such care was the recognition and support of the infants' individual levels of competence and active goal striving in shaping their own development. Infants were seen as collaborators in the care they received. To this end, formal observations of each infant's behavior were conducted, starting during the phase of infant stabilization and subsequently every seven days until hospital discharge. For each observation, the infant's responses were systematically recorded for approximately 20 minutes before a necessary medical or nursing caregiving activity, throughout the duration of the caregiving, and for approximately 20 minutes after the caregiving activity. Ninety-one behaviors, including autonomic (respiration, heart rate, color changes, visceral signs), motor (postures, muscle tone fluctuations, movements), and state organizational behaviors (levels of arousal, patterns of transitions between states, clarity and robustness of sleep and awake states), were monitored every two minutes.[22] Interrater reliability was established at greater than 85% accuracy. Behaviors were conceptualized as stress (e.g., flaccidity, agitated or frantic movements, hyperextensions, duskiness, respiratory pauses, gagging, spitting up, finger splaying, arching, gaze aversion, etc.) or regulatory behaviors (e.g., hand to mouth, hand clasping, grasping, efforts to suck, tucking, etc.), and interpreted as indices of the infants' current vulnerabilities and strengths, respectively. The observations were used to formulate

Medical Background and Outcome

Following discharge, the infants' medical records, after removal of the neurobehavioral reports, were reviewed by trained research staff blind to the group status of the infants and the goals of the study. Medical background variables assessed included: birthweight (g); mode of delivery; obstetric complications; gestational age at birth [20]; Apgar scores [21] at one and five minutes; and Mean Daily Pulmonary Index, defining oxygen requirements for days one and two (MDPI; Sell 1990, personal communication). Maternal variables included: Obstetric Complications Scale Score [OCS; [22]]; marital status; ethnicity; parity; socioeconomic status,[23] and Social Readjustment Rating Scale Score,[24] measuring degree of stressful life events.

Medical outcome variables included: Number of days with supplemental oxygen; MDPI for days three through ten; number of days with reported apnea episodes; incidence of hyaline membrane and chronic lung disease by double-blind chest radiograph review; incidence of intraventricular hemorrhage by double-blind cranial ultrasound review; incidence of retinopathy of prematurity; number of days of hyperalimentation and gavage feeding; incidence of necrotizing enterocolitis; average daily weight gain (g) from birth to hospital discharge and to two weeks post due date; number of days in hospital; number of medical diagnoses at discharge; age post LMP at discharge (wks); and weight (g) at two weeks post due date.

Developmental Outcome

Behavioral outcome was evaluated with the Assessment of Preterm Infants' Behavior (APIB),[25,26] using the 32 standard apriori variables[27] and the Neurological Examination of the Full-Term Newborn Infant,[28] using 10 summary scales and one total score.[29] Examiners were unfamiliar with the group status of the infants and with the goal of the study.

linear effects of initial group difference between the two preterm groups in medical background data. Pearson product-moment correlation analysis was employed to explore the relationships between the neurophysiological variables and the APIB behavioral variables.

RESULTS

Age at assessment was comparable for all three groups [Control Preterm: mean 2.0 (standard deviation 3.3); Experimental Preterm: 2.7 (1.8); Fullterm Comparison: 2.2 (0.5) weeks post-EDC; $p = 0.69$].

The two preterm groups were comparable on all medical, family background, pregnancy and delivery parameters, with two exceptions, as Table 1 shows. The preterm

— Table 1 about here —

experimental group was initially significantly more at risk, as reflected by greater maternal obstetrical complications (OCS; $p < .04$) and higher oxygen requirements, as measured by MDPI ($p < .03$). Therefore, OCS and MDPI were used as covariates for further analyses. As expected, the two preterm groups were significantly lower in gestational age at birth, birthweight, Apgar ratings, MDPI, and OCS scores than the fullterm groups. None of the parent background measures showed any preterm-fullterm differences.

Medical Outcome

None of the medical outcome measures showed significant between-preterm group differences. The preterm control and experimental groups were discharged from the hospital after 29 (10.64) and 27 (10.65) days, respectively, at a mean age post LMP of 36 weeks for both groups [36 (1.16) vs. 36 (1.19)]. At 2 weeks post term there were no significant weight (g) differences between the two groups and fullterm group [preterm

showed an orderly progression of the three groups, with the preterm control group the least well modulated, the preterm experimental group second, and the fullterm group the most well modulated.

Electrophysiological Outcome

Each of the five EP states yields 36 operationally independent comparisons, based on their 36 epochs of 40 msec duration each. This results in a total of 180 possible variables, or numerical features, for analysis of between-group difference using the t-SPM technique.[30] Of these 180 possible features, seventy showed significant group difference between the two preterm groups. Nineteen of the 70 resulted from VERA, 12 from VERQ, 13 from SPE, 14 from NSP, and 12 from CLK. Twenty-eight involved the right hemisphere; 24 the left hemisphere; and 18 were bihemispheric. By chance, only nine features would have been expected to reach significance at the <.05 probability level.[38]

When the three groups were compared with ANCOVA, 41 of the 70 features continued to show significant among group differences. In a significant number of these, namely 32 of the 41, the preterm experimental group was comparable to the fullterm group, while both differed from the preterm control group (χ^2=34.6, df=1, significant at p≤.01). This suggests that the frequency of similarity observed between the fullterm and the experimental preterm group is not a chance finding.

Figure 4 displays the 41 regions showing significant group differences. The area

— Figure 4 about here —

most frequently involved was the frontal lobe, with 18 features; 12 features involved the temporal region and the remaining 11 the central, occipital and parietal regions. Of the 41 features, 28 showed significant correlations with APIB behavioral measures. Thirteen of these significant correlations were between the frontal lobe features and APIB variables measuring attentional control and state organization. An additional nine features

stabilization and continuing developmental progression. Individualized special care provided by the preterm infants' parents in collaboration with their nursery careteams and supported by a developmental nurse and psychologist may provide an extrauterine environment that supports development especially of the frontal lobe, which appears differentially sensitive to unexpected environmental stimuli. Preterm infants, whose births may have triggered the early onset of sensitive periods, show improved functioning with the intervention approach perhaps due to the smooth and integrated incorporation of extrauterine sensory experiences during this period of rapid neural development.

References

1. U. S. Department of Health and Welfare, Public Health Service, National Center for Health Statistics. Births, marriages, divorces and deaths. *Monthly Vital Statistics Report*. 1993; 42:6-42.

2. Als H, Duffy FH, McAnulty G, Badian N. Continuity of neurobehavioral functioning in preterm and full-term newborns. In: Bornstein MH, Krasnegor NA, eds. *Stability and Continuity in Mental Development*. Hillsdale, NJ: Lawrence Erlbaum; 1989:3-28.

3. Duffy FH, Als H, McAnulty GB. Behavioral and electrophysiological evidence for gestational age effects in healthy preterm and fullterm infants studied two weeks after expected due date. *Child Dev*. 1990; 61:1271-1286.

4. Hunt JV, Tooley WH, Cooper BAB. Further investigations of intellectual status at age 8 years: I. Long-term consequences into adulthood. II. Neonatal predictors. In: Friedman SL, Sigman MD, eds. *Advances in Applied Developmental Psychology, Volume 6. The Psychological Developmental of Low Birthweight Children*. Norwood, NJ: Ablex; 1992:315-337.

5. Hunt JV, Tooley WH, Harvin D. Learning disabilities in children with birthweights < 1,500 grams. *Semin. Perinatol*. 1982; 6:280-287.

6. Largo RM, Molinari L, Kundu S, Lipp A, Duc G. Intellectual outcome, speech and school performance in high risk preterm children with birth weight appropriate for gestational age. *Eur J Pediatr*. 1990; 149:845-850.

7. Sostek AM. Prematurity as well as intraventricular hemorrhage influence developmental outcome at 5 years. In: Friedman SL, Sigman MD, eds. *Advances in Applied Developmental Psychology, Volume 6. The Psychological Development of Low Birthweight Children*. Norwood, NJ: Ablex; 1992:259-274.

18. Als H, Lawhon g, Duffy FH, McAnulty GB, Gibes-Grossman R, and Blickman JG. Individualized developmental care for the very low birthweight preterm infant: Medical and neurofunctional effects. *JAMA*. In press.

19. Als H, Lawhon G, Brown E, et al. Individualized behavioral and environmental care for the very low birth weight preterm infant at high risk for bronchopulmonary dysplasia: Neonatal Intensive Care Unit and developmental outcome. *Pedia*. 1986; 78:1123-1132.

20. Ballard JL, Khoury JC, Wedig K, et al. New Ballard score, expanded to include extremely premature infants. *J Pediat*. 1991; 119:417-423.

21. Apgar V. A proposal for a new method of evaluation of the newborn infant. *Anesth Anal*. 1953; 32:260-267.

22. Littman B, Parmelee AH. Manual for Obstetric Complications. Infant Studies Project, Department of Pediatrics, School of Medicine, University of California, Los Angeles, CA, 1974.

23. Hollingshead AB. Four Factor Index of Social Status. Working Paper. Yale University, New Haven, 1975.

24. Holmes TH, Rahe RH. The social readjustment rating scale. *J Psychosom Res*. 1967; 11:213-218.

25. Als H, Lester BM, Tronick EZ, Brazelton TB. Towards a research instrument for the assessment of preterm infants' behavior. In: Fitzgerald HE, Lester BM, Yogman MW, eds. *Theory and Research in Behavioral Pediatrics. 1*. New York: Plenum Press; 1982:35-63.

26. Als H, Lester BM, Tronick EZ, Brazelton TB. Manual for the assessment of preterm infants' behavior (APIB). In: Fitzgerald HE, Lester BM, Yogman MW, eds. *Theory and Research in Behavioral Pediatrics. 1*. New York: Plenum Press; 1982:65-132.

38. Maus A, Endresen J. Misuse of computer-generated results. *Med. Biol. Eng. Comput.* 1979; 17:126-129.

39. Huttenlocher PR. Synapse elimination and plasticity in developing human cerebral cortex. *Am. J. Ment. Defic.* 1984; 88:488-496.

40. Schade JP, van Groenigen DB. Structural organization of the human cerebral cortex. I. Maturation of the middle frontal gyrus. *Act Anatom.*1961; 41:47-111.

41. Yakovlev PI, Lecours AR. The myelogenetic cycles of regional maturation of the brain. In: Minkowsky A, ed. *Regional Development of the Brain in Early Life.* Oxford: Blackwell; 1967:3-70.

TABLE 1. Medical and Demographic Background Variables

	Group				Pairwise Comparisons		
	Preterm Control (I): n=12	Preterm Experimental (II): n=12	Fullterm Comparison (III): n=12	*p*	I&II *p*	I&II *p*	II&III *p*
Gestational Age at Birth	32.14 (1.12)	32.19 (0.86)	39.48 (0.70)	0.0001	0.91	0.0001*	0.0001*
Gender (male, female)	3 / 9	6 / 6	5 / 7	0.44	0.21	0.39	0.68
Birthweight (g)	1707.00(424.00)	1732.00(439.00)	3379.00(311.00)	0.0001	0.89	0.0001*	0.0001*
Apgar Ratings: 1 minute	7.08 (1.38)	6.08 (1.93)	8.33 (0.78)	0.002	0.15	0.01	0.002*
Apgar Ratings: 5 minutes	8.50 (0.80)	8.08 (0.52)	8.92 (0.29)	0.004	0.15	0.11	0.0001*
Mean Daily Pulmonary Index (Days 1-2)	0.25 (0.26)	0.71 (0.62)	N/A	N/A	0.03	N/A	N/A
Obstetric Complications Scale Score	68.83 (12.19)	58.67 (10.76)	115.25 (17.13)	0.0001	0.04	0.0001*	0.0001*
Mother's Age (years)	28.33 (6.97)	28.83 (5.29)	30.42 (6.86)	0.71	0.85	0.47	0.53
Parity	0.50 (0.52)	0.50 (1.00)	0.92 (0.90)	0.38	1.00	0.18	0.30
Social Readjustment Rating Scale	0.19 (0.10)	0.19 (0.04)	0.19 (0.11)	0.99	0.85	0.97	0.90
Social Class (I & II; III; IV & V)	7 / 1 / 4	8 / 3 / 1	7 / 2 / 3	0.58	0.24	0.79	0.53
Marital Status (partner, single)	12 / 0	10 / 2	12 / 0	0.12	0.14	1.00	0.14
Ethnicity (Cauc., Afr.Am., Hisp., Other)	6 / 4 / 2 / 0	4 / 7 / 0 / 1	7 / 3 / 2 / 0	0.35	0.24	0.90	0.14

Results are means (SD). One-Way Analysis of Variance Test, Two-tailed: F, and Chi-Square Test, Two-tailed: $\chi 2$
*Pairwise Comparisons with Bonferroni adjustment for multiple comparisons ($p \leq .05$)

LIST OF FIGURES

Figure 1 APIB Subsystem Variables

Figure 2 APIB Summary Variables

Figure 3 Prechtl's Neurological Examination of the Full-Term Newborn Infant

Figure 4 Evoked Potential Regions of Among Group Difference

Fig. 1. Means and standard deviations of the APIB subsystem scores for the preterm control, preterm experimental, and fullterm comparison groups derived from the behavioral examination at 2 weeks post expected date of confinement (EDC). Behavioral systems are the autonomic system, the motor system, the state organizational system, the attentional system, the self regulatory system, and the degree of examiner facilitation necessary in the course of the examination. All system scores are scaled from 1 to 9, with 1 representing well-organized performance and 9 representing poorly organized performance. The six system scores are based on means of 18 scores per system obtained in the course of an examination for each child on the autonomic, motor, state, and self-regulation system; the means of three scores are obtained on the attentional system, and the means of six scores on the variable examiner facilitation.

Fig. 2. Means and standard deviations of the APIB summary scores showing significant differences between the preterm control, preterm experimental, and fullterm comparison groups at 2 weeks post-EDC. Summary scores are scaled from 1 to 9, with 1 representing poorly organized performance and 9 representing well-organized performance. State stability measures a combination of parameters which include lability of states, ability to quiet when motorically aroused, ability to be consoled when motorically aroused, rapidity of build up to motoric arousal, peak of motoric arousal, and degree of discharge smiles versus stimulus-related smiles in alertness. Autonomic parameters include the degree of tremulousness, startles, skin color lability and the threshold to color change. Motor maturity measures the degree of flaccidity versus hypertonicity and the degree of smoothness and control of limb movements. State regulation consists of the range and flexibility of states, irritability, robustness in handling the examination, control over input, and improvement with facilitation. Behavioral attractiveness measures the overall organization and modulation paired with social responsiveness and engagement.

Fig. 3. Means and standard deviations for those summary scales from the Prechtl Neurological Examination of the Full-term Newborn Infant showing significant differences among the three groups, preterm control, preterm experimental, and fullterm comparison groups. Posture measures the parameters of asymmetry, opisthotonos, and frog positioning. Motility includes hyperkinetic and hypokinetic patterns of movement Pathological movements summarize overshooting movements, convulsions, twitching of the face, and the incidence, frequency, and amplitude of tremors. The total abnormal score summarizes all of the summary scales, including: posture, motility, pathological movements, motor system tone, intensity of the responses, the Moro response, state stability, crying, hemisyndrome, and syndromes of abnormal reactivity.

Fig. 4. Forty-one regions of significant difference ($p \leq .05$) among the three groups are shown by qEEG with topographic mapping. Schematic representations are of head areas as seen from above (i.e. nose at top, right ear on right side), arranged by locations of regions of difference (ROIs): frontal, temporal, central, occipital, and parietal. Each individual representation indicates the region of difference (white area), evoked potential condition (VERA, VERQ, SPE, NSP, CLK), and starting msec of the 40 msec time period for which a significant between group difference was identified. The location of the electrode measuring the peak between group difference is in parentheses; identified by region (F = Frontal, FP = Fronto-Polar, T = Temporal, W = Wernicke's, C = Central, O = Occipital, P = Parietal) and side (odd numbers indicate left hemisphere, even numbers right hemisphere, and Z bihemispheric electrode placement).

Role of reflective process in the implementation of developmentally supportive care in the newborn intensive care nursery

The National Collaborative Research Institute on Early Childhood Intervention (NCRI-ECI) multisite study of the effectiveness of family-focused, developmentally supportive care with low birthweight infants consisted of an experimental component and a reflective process component. This article describes the reflective process component, which is essential because of the theory-guided, relationship-based, and systems-oriented nature of developmental care; the complexity of the neonatal intensive care unit (NICU) environment; and the need for organized support for change and growth in NICU practice. Key words: *developmentally supportive care, NICU, reflective process*

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Let me tell you about the first developmental nurse. She seemed to do better at gavage feeding than the others. I watched how she fed the babies. She put the tube in and then she'd stroke around the baby's belly, just like she was calming him. We noticed the babies fed a lot better, didn't spit up as much, and gained weight better. So we noticed that, and our thought was, why doesn't everybody do it?

— Senior neonatologist recalling his first awareness of developmental care 25 years ago

WHAT THIS NURSE was doing seems deceptively simple. However, as the physician observed, the results of her caregiving demonstrate the association among infant behavior, caregiving practices, and treatment outcome. When nurses or physicians become aware of these connections in their practice, developmental care becomes a natural part of their caregiving roles. Although individuals may practice care within a developmental perspective, the changes that result from the formal inclusion of this perspective as a framework for all neonatal intensive care unit (NICU) care are not easily attained nursery-wide. An experienced nurse described developmental care as the most profound change that has occurred in neonatal nursing practice. What makes developmental care so challenging? Why isn't it practiced by everyone? How can nursery staff and developmental leaders be supported as they move toward a model of developmentally supportive care?

Inf Young Children 1995; 7(4): 20–28
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281

The National Collaborative Research Institute on Early Childhood Intervention (NCRI-ECI)[1] examined the effectiveness of developmental care and the process of its implementation in five nurseries. In this article, we present a description of the research project; the format, implementation, and conceptual framework for reflective process as a component of developmentally supportive care; and recommendations for its inclusion in nursery practice.

RESEARCH PROJECT OVERVIEW

NCRI-ECI[1] was funded by the Office of Special Education and Rehabilitation Services (OSERS) as a multisite study of the effectiveness of family-focused, developmentally supportive care with very low birthweight infants. The NCRI-ECI experimental component was based on prior promising research studies at Brigham and Women's Hospital in Boston.[2,3] These studies showed that preterm infants benefited both medically and developmentally when they received developmentally supportive care beginning in the first week after birth. The developmental approach was based on the Newborn Individualized Developmental Care and Assessment Program (NIDCAP).[4] Using the Synactive Theory of Development[5] as a guide, the NIDCAP approach sees the infant as an active collaborator in his or her care, cherished by a family and determinedly striving for best outcome. A systematic method for the detailed observation of the infant's behavior and for the use of each infant's unique repertoire of strategies as a guide for caregiving provided the empirical database. A developmental psychologist, in partnership with a developmentally trained clinical nurse specialist, conducted NIDCAP observations every 10th day. From these observations, detailed reports with suggestions for ways to support the infant's physiologic stability, behavioral organization, and developmental progression in the context of the family's development were prepared and shared with the parents and the infants' care teams. In addition, continued support was offered to the care teams and to the families.[6]

The NCRI-ECI experimental component examined the question of effectiveness of the NIDCAP approach on a larger scale. Could the model of integrated and individualized developmentally supportive care be implemented successfully across five sites by a team of trained specialists at each site? The experimental protocol[7,8] again included weekly formal bedside observations and continued consultation and support offered to the families and the caregiving team by a developmental specialist and a developmentally trained nurse.

REFLECTIVE PROCESS

The goal of the second NCRI-ECI component was to examine the process of change during the course of the experimental study. The co-director (LG) designed and implemented an approach to interviewing key nursery staff members and research team personnel at regular intervals in order to understand their perspectives on the issues, concerns, and successful strategies. In addition, a format for providing feedback to the research team was developed and implemented. This opportunity to reflect individually and collectively on the process of implementation was of sufficient benefit to the research team that it emerged as an essential component of developmental care, to be explicitly built into the implementation process.

Format and Implementation

The co-director conducted reflective process interviews and feedback sessions at each of the five nurseries during 3-day visits scheduled at 6-month intervals over the course of 4 years. The first 2 days consisted of individual interviews with key personnel. The 3rd day consisted of a feedback session with the research team and consultation with the site research director.

Interviews

Typically, the medical director, nurse manager, and members of the research team were interviewed at each visit. In advance of the visit, the research team identified 6 to 10 other individuals to

be interviewed, including parents, staff nurses, attending physicians, clinical nurse specialists, assistant nurse managers, and a range of multidisciplinary support staff including respiratory therapists, social workers, occupational and physical therapists, and unit secretaries. In addition, professionals in post-NICU roles were included, (eg, personnel from infant follow-up programs, early intervention programs, and state agencies). Over the course of the study, 162 individuals were interviewed, for a total of 295 interviews. The individual 1-hour interviews were open-ended inquiries regarding two areas hypothesized to influence implementation: nursery organizational variables and developmental care implementation variables.

The interviewer adopted an exploratory posture, as described by Tomm,[9] listening intently, with an accepting openness to learning from the interviewees and to hearing their particular perspective on the larger nursery system and the developmental work. The interviewer listened for patterns that connected what the interviewees were saying with their past perspectives and with the viewpoints of others. The interviewer neither attempted to correct the individuals (except in a few instances to provide accurate factual information about the project) nor tried to persuade them to change their minds. Negative emotions were accepted and, if appropriate, explored together in an effort to understand the dynamics underlying the feelings and any implications for the developmental work. By agreement, specific information from one interviewee was not shared with another. This practice offered interviewees a degree of privacy for the individual sessions and a sense of participation in a collective effort.

Initial interviews usually began by asking the interviewee about what interested them in working in the field of newborn intensive care, their history with developmental work, and their current perspective about the progress of the developmental study. On repeat interviews, the individuals were asked about the progress of their own work and about the progress of the study from their perspective.

The sessions provided the individuals interviewed with an uninterrupted hour to share their experiences over the past 6 months; to think about the evolution of their roles; to mark their progress; and to reflect upon the developmental work, the dynamics of the setting, and the interweaving of the parts into a whole. Stepping away from the intense day-to-day work allowed an opportunity to reflect upon the strong emotions and, at times, uncomfortable doubt, which intermittently accompany the intense and demanding work of implementing developmentally supportive care in an NICU. As co-director, the interviewer held a recognized status in the project hierarchy. The ability to listen to the interviewees' strong feelings, while still being identified with the project leadership, helped to create a sense of safety within which the interviewees could explore for themselves aspects of the work they had not accessed previously. At times, the interviews appeared to serve as a holding environment or container for the tension inherent in change. The sessions provided the professionals not directly involved in the research effort with a safe time, and perhaps for some the only time, to put into words their feelings about the challenges of their work. Several of the leadership management staff expressed how they looked forward to the semi-annual hour, carved out of their extremely demanding schedules, as a time to hold the process still and reflect on it.

As with any kind of change, individuals have different responses. The inclusion, by invitation, of a large number of persons at different places in their own understanding of and identification with developmental work helped acknowledge and value each person, regardless of their beliefs about developmental care.

Feedback sessions

After the interviews were completed, a half-day feedback session was conducted with the research team. This session offered an opportunity for feedback on common themes, description of the organizational dynamics of the sites, and reflection upon the rich collection of insights and information

gained directly from the experience of the team and their colleagues. Planning and problem-solving occurred but were not a primary focus of group activity. At times, the interviewer offered metaphors or encouraged the group to think of metaphors to capture the rich tapestry of the experience being shared. The sessions generally were most helpful when the process allowed the participants to absorb the complexity without a push for specific solutions or an expectation for responding quickly with actions or new plans. However, in several instances, when a team was dealing with an immediate, pressing concern (eg, budget cuts/impending staff layoffs), the session became more concrete to help contain anxiety and articulate workable, short-term plans. To strengthen a sense of community and enhance group effectiveness, team-building activities were interwoven with time for sharing a meal and relating stories. It was clear that the research team members, who were giving much energy to this complicated and highly visible project, profitted from feeling and being nurtured. Each visit ended, as it generally began, with an individual session with the site's research team director for the purpose of support and consultation.

CONCEPTUAL FRAMEWORK

Educational theorists have offered a range of conceptual frameworks for reflection: reflection as critical inquiry,[10] reflection as rationality and responsibility,[11] reflection as accountability,[12] reflection as experimentation or knowing-in-action,[13,14] and reflection as self-knowledge.[15] The ZERO TO THREE Work Group on Supervision and Mentorship propose that reflection, along with collaboration and regularity, is one of the foundations of quality supervision.[16] Their definition of reflection is "the continuing conceptualization of what one is observing and doing."[16(p10)] Two themes are present in each of the definitions of reflection: reflection is a form of learning and reflection is a valuable tool to improve practice. Reflection is of particular value to developmental care because of the nature of the developmental approach itself, which is theory-guided, relationship-based, and systems-oriented.

Reflection and the theory-guided nature of developmental care

The Synactive Theory of Development,[5] which serves as a conceptual framework for the NIDCAP approach, focuses the observation of infant behavior and formulation of caregiving plans and highlights the concept of co-regulation[6] as central for the understanding and support of the primacy of the relationship between the infant and family. Individualized care plans are developed and continually updated in concordance with the infant's and family's ongoing, dynamic process of development. Implementing a theory- rather than a procedurally-guided approach is challenging in any setting, and perhaps especially challenging in acute care environments, which by necessity are oriented to standard protocols and caregiving routines. Schön's conceptualization of "reflection-*in*-action"[13,14] is particularly apt in these circumstances. Schon compares "reflecting-in-action" to "thinking on your feet."[13(p54)] Tremmel[17] summarizes the capacities underlying "thinking on your feet" as "processes of 'feeling,' 'seeing,' or 'noticing' what it is you are doing; then learning from what you feel, see, or notice; and, finally, intelligently, even intuitively, adjusting your practice."[17(p436)] Thus, Schön's reflective practitioner operates as a researcher on the scene, not in a search for solutions or certainty but "focusing on the present moment, simultaneously doing and learning and coming to know."[17(p438)] Tremmel[17] introduces the Zen practice of mindfulness as an illustration of the mental processes that support reflective practice. "Mindfulness is to go toward the center of what you are doing. When you begin teaching [providing care] the mind will go in many directions . . . the practitioner needs to return to mindful awareness . . . to invest in the present moment with full awareness and concentration."[17(p451)] He cites Langer's[18] definition of "mindlessness," as "thought and action 'entrapped' by reified categories and habitual and 'automatic behavior.'"[17(p445)]

A senior staff nurse described the "familiar formulas" that have shaped nursing care in the past. "So much of nursing is doing routine things in a routine way." She articulated the difference in her practice when she began working in a unit that valued a developmental approach and that encouraged critical thinking: "I used to suction every 3 hours, regardless. Now I think, 'Who am I suctioning for—me or the baby?' I watch now for the signs that he needs to be suctioned. I knew what to do before, now I know why."

Tremmel[17] points out that to be open to reflection one has to change the way one's mind works. The implementation of a theory-guided approach to developmental care requires the encouragement of flexible minds, comfortable with "doing, learning, and coming to know."[17(p438)]

Reflection and the relationship-based nature of developmental care

Developmental care is a professional alliance that supports the parents' engrossment with their child and the child's expectations for nurturance from the family and that listens to the language of the infant's and family's behavior and uses the dialogue between infant and parent and professional caregivers to guide care.[19] Each facet of this conceptualization refers to relationships: relationships between colleagues and between infants, families, and professional caregivers. Relationships imply connections. It is not possible to encourage relatedness and yet act unrelated. In fact, nurses who embrace a developmental approach begin to speak about their practice in new ways that acknowledge the connections between themselves and the infants and families for whom they care:

> I used to think 'I'm going to go in, put a suction catheter down the endotrachial tube. I'm going to change a diaper, I'm going to flip him, I'm going to close the door, and I'm going on to my next job and I'm not going to look in again until I have more tasks to do on him.' I knew what I had to do that day but I really didn't have a sense of who the little person was I was relating to.
>
> My mindset is different now. Now I think when I go into the isolette, it's almost like a visit. I'm coming in to communicate with you [baby] and the baby's going to communicate back with me. I'm going to observe and assess the infant and there are some things I have to do, but I'm going to watch what he's telling me and adjust what I have to do given the cues that he's giving me. . . . I feel connected, so much more in tune.

This new connection with the infant strengthens the capacity to nurture relatedness between parent and child:

> Before I learned about the developmental approach, I didn't talk about his capability to respond or communicate. I didn't teach about his humanness . . . I focused on fixed traits like he's got blue eyes . . . I didn't talk about how he was responding to the world. I didn't say things like...look how he calmed down to your touch. . . . Now I think I facilitate parents seeing the infant like a family would, knowing their baby at home.

Fenichel notes that such work with relationships engages the emotions as fully as the intellect:

> Very young children stir powerful feelings in adults (the species is programmed that way). Moreover, parents and parent–child interaction evoke complex responses in professionals that are often difficult to sort out and respond to in ways that support the parent, the child, and the relationship between them.[16(p10)]

A basic tenet within the mental health disciplines is that work with relationships requires ongoing supervision. This means that time must be set aside on a regular basis, with an experienced and trusted colleague, to explore the "imperfect processes"[20] of professional practice and one's responses to the work. Shanok's eloquent essay describes supervision as a place where "strengths are emphasized while vulnerabilities are partnered."[21(p40)] "In daily work, the professional is on the spot and must make a multitude of moves in a given situation. 'Out there' she learns by doing; in supervision, she learns by reflection."[21(p37)]

Schön's second concept of "reflection-*on*-action"[13] offers similar impetus to slow down the process and to reflect. Tremmel refers to "reflection-on-action" as a "mode of research activity, undertaken in tranquility, off-line, which Hannah Arndt has called a 'stop and think.'"[17(p446)] That is, stepping back in order to go forward.

Slowing down the process, holding a steady state for reflection, is central to the quality of all infant/

family work. It may be particularly crucial for relationship building in the environment of the newborn intensive care nursery. The fast-paced, emotionally charged, stop-and-go world of the NICU has been described as an environment whose roots are in emergency medicine where quick differential diagnosis, highly focused and segmented care, and reliance on professional authority have been the therapeutic agents. This is an environment where power for decision making has traditionally resided in social distance and the use of technology and data, rather than in personal interaction.[22]

Developing relationships is challenging for all professionals, but perhaps especially so for individuals within the nursery whose professional identity is tied to technology. A charge nurse described the dilemma this way:

> We are high-tech nurses. We all love machines. We love to touch them and fool with the dials. . . . It is almost incompatible to incorporate both sides—a loving nurse and a high-tech nurse. We're not nurturing people who can sit and hold a hand. I think 'Oh, I've got to fool with the monitor.' We are high-energy road runner types. We love action. Most of us won't pay that much attention to behavior. We love the numbers.

While her present competence is in the technical aspects of care, she is very aware of the importance of relationships and the link to developmental care:

> Other nurses are more low-key—you can sense it in their aura. You have to mature to see that negative behaviors [caregiving practices] bring about a negative reaction in the baby. On nights they see this. I'm not into that. I do like kangaroo care though [parents holding their infant skin-to-skin]. Every baby deserves to have somebody and get love.

One of the roles of the developmental professional, then, is to begin to understand each nurse and to develop relationships that respect the nurse's values, beliefs, and abilities and that offer useful and timely support. A clinical nurse specialist described the task of the developmentalist as that of creating a "resource relationship" with each nurse. What attributes does this relationship require? Nurses and physicians reported the following characteristics as important qualities of the developmental professional: available, accessible, and quickly responsive; logical, practical, and substantive; patient-focused and receptive to staff needs; enthusiastic, helpful, and pleasant.

To create a "resource relationship," the developmentalist needs to be emotionally available and physically present: It is the timing of the contact, not only the proximity, which appears to be crucial. Developmentalists need to be continuously attuned in their interactions. That is, their responses should be guided by the present circumstances at the bedside and the caregiver's cues, rather than by a predetermined agenda, independent of the current context. In all interactions, the developmentalist seeks to model the primary principle for supporting the development of relationships: Do unto others as you would have them do unto others.[16]

Developmentalists need to be highly knowledgeable about and passionately committed to developmental care, while at the same time staying engaged with others despite apparent differences. A developmental nurse describes the challenge this way:

> When you're butting heads and you feel that competition and you feel like you just know you are right, you have to communicate. You have to start saying things like 'Tell me what you mean. I understand your perspective is important too.' Sometimes I want so much for people to listen, my voice is quavering. But if we sit down and talk about it, there can be genuine sharing.

Bettelheim[23] offers guidance for holding another person's feelings and staying connected to them. He states that when we don't know how to perceive of another's behavior, we are obliged to give them the benefit of the doubt. "We can begin to understand another person's behavior only if we start with the assumption that the reasons or motives that lie behind his actions . . . seem good to him."[23(p107)]

We have to look closely at all details and take them seriously and ask: "What might he have been trying to achieve?" and "Against whom or what might he have been reacting?"[23(p107)] and "proceed on the assumption that the other person's thoughts and actions are worthy of being considered in the most positive way possible."[23(p119)]

Bettelheim describes the tendency persons have to distance themselves from others. Instead, he states that we must try to see other persons as

persons like ourselves and think: How would I feel and react if I were in this situation? We need to have empathy for what motivates others, believe that people have good reasons for their behavior, and stay connected in a way that is useful.

Belenky and colleagues write about the benefits of recognizing multiple perspectives. "If one can discover the experiential logic behind these ideas [those of the 'other'], the ideas become less strange and the owners of the ideas cease to be strangers. The world becomes warmer and more orderly."[20(p115)]

The implementation of developmental care requires a high degree of intrapersonal and interpersonal knowledge. The skills to support the development of relationships, to take multiple perspectives, and to respect the time required to bring about change are high-level skills. When the demand for these capacities is great, so is the need for reflection. Whether in individual sessions or within a supportive group process, members of the developmental team must have time to examine their own practice, to explore feelings, and to feel nurtured and understood.

Reflection and the systems-oriented nature of developmental care

In addition to its fundamental relational nature, developmental care is a multifaceted, systemwide intervention affecting the interdependencies among different groups in the nursery and across disciplines working in the NICU environment. At least five social systems are integral to the implementation of developmental care: the infant and his or her parents, the family, the NICU system itself, the hospital, and the community.[21] All those engaged in developmental care must be aware of the dynamics of a systems orientation.

From an organizational framework, Huse[24] describes the essential features of a systems approach. Problems are embedded within a situation and are multiply determined by forces working in complex relationships; any solutions have intended and unintended affects; change in any one part of the system frequently has larger effects over the entire organization; and conversely, the subunit is affected by the supraorganization.

To grasp a systems perspective, it is necessary to step back from the immediate situation and examine the forces in the larger environment. The reflective process feedback sessions, in particular, provided an opportunity for each team to see the bigger picture. What did this entail? First was an opportunity to describe the elements of the larger system. Cooperrider and Srivasta assert that the way one comes to know a system is "fateful."[25(p135)] Rather than focusing on problems, they advocate for identifying the life-giving forces in an organization. Based on their model of "Appreciative Inquiry,"[25] the research teams were given the opportunity to reflect upon the question: What gives this unit life, vitality, and distinctive competence? Is it technical excellence, collaborative practice between physicians and nurses, or superb discharge planning? From this process, an approach was developed to guide each team through an oral history of their unit and of the developmental work.[26] Sharing the history offered an opportunity for teams to appreciate the phases that the unit has experienced and the progress of the developmental work and to develop a renewed sense of community and belonging to a larger effort. In addition, the teams were helped to explore the more traditional features of unit culture (eg, leadership style, communication patterns, and conflict resolution styles, as identified by Shortell et al[27]).

Through the visits, units were observed to cycle through periods of equilibrium and disequilibrium. The degree of organizational stability in the setting appeared to have an impact on the receptiveness of the nursery to developmental care. A range of organizational factors influencing nursery stability were identified.[26] These factors pertain to financial stability, staff relationships, staff changes, and critical unit events. Factors related to site complexity also influenced unit equilibrium (eg, nursery complexity factors such as nursery size, staff size, acuity, census, and staff ratios; and family complexity factors such as percentage of families with extreme environmental stress). Teams were helped to use these factors to assess the current systems' balance within the nursery and to reflect upon the relationship between the nursery's equilibrium and the developmental work.

Miller[28] states that an effective learning organization must have two components: one hierarchically structured for short-term productivity and a second, non-hierarchical component for ongoing scanning and for examination of process. Opportunities for reflective process, such as those that were employed in the NCRI-ECI study, can help teams maintain a learning posture as they move toward the adoption of a developmental care framework.

RECOMMENDATIONS

Based on the lessons learned regarding the value of reflective process in the NCRI-ECI study, the following recommendations are offered.

First, relationships are central to the goals and the implementation of developmentally supportive care. Like other practitioners whose work focuses on supporting the development of relationships, NICU nursery personnel should be provided with opportunities to reflect upon and to process both the objective and subjective aspects of their work. Individual and group support should be available on a regular basis for *all* clinical and administrative staff. Weekly, individual supervisory sessions modeled after those described by Shanok[21] are particularly important for developmental professionals because of the high role demand for interpersonal and intrapersonal knowledge and skill. As in other settings, it is the responsibility of leadership to ensure that these supervisory opportunities are put in place.[29] While individuals with a variety of backgrounds can provide supervisory support, it is recommended that each unit have a trained mental health professional on staff to serve in this role. This professional must be knowledgeable and skilled in a range of areas and must share this knowledge and skill within the dynamics of the NICU. The knowledge areas include, but are not limited to, individual and group dynamics, adult development and learning, family systems, and infant mental health theory and practice. The knowledge of adult mental health diagnoses and helpful approaches to interaction related to these diagnoses is essential. Knowledge of the concepts of organizational behavior and change theory are of key importance.

Second, in addition to clinical and administrative support, each nursery should build into its approach to developmentally supportive care regular opportunities to reflect upon the process of implementation itself. The structure and process for reflection should be collaboratively designed and implemented with the support of a process consultant. In some instances, the mental health professional could serve in this role. However, the advantage of an outside process consultant contracted for this purpose should not be underestimated. At a minimum, at 6-month intervals, it is recommended that the core developmental team and nursery leadership set aside a period of undivided time to take stock of the work. As illustrated in the NCRI-ECI reflective process component, these step-back sessions should solicit and value the input of all persons affected by the developmental work. With the support of the resource consultant, the nursery can reflect upon its own evolution toward developmentally supportive care and, through this process, gain a deeper understanding not only of the developmental work but also of the nursery as a whole and of the interconnectedness of all aspects of care.

In summary, the process of reflection undergirds the continuing conceptualization of care delivery, the multisystem collaboration in the NICU, and the personal and professional growth of all involved. The inclusion of reflective process as a component of developmentally supportive care helps the nursery become a place where "strengths are emphasized while vulnerabilities are partnered."[21(p40)]

REFERENCES

1. Als H. National Collaborative Research Institute for Early Childhood Intervention (NCRI-ECI): Family-focused developmental care and intervention for the very low birthweight preterm infant at high risk for severe medical complications and developmental disabilities. U.S. Department of Education, Office of

BEST COPY AVAILABLE

Special Education, Grant #H024S9003, 1989.
2. Als H, Lawhon G, Brown E, Gibes R, Duffy FH, McAnulty GC, Blickman JG. Individualized behavioral and environmental care for the very low birth weight preterm infant at high risk for bronchopulmonary dysplasia: Neonatal intensive care unit and developmental outcome. *Pediatrics*. 1986;78:1123–1132.
3. Als H, Lawhon G, Duffy F, McAnulty G, Gibes-Grossman R, Blickman J. Individualized developmental care for the very low-birth-weight infant: medical and neurological effects. *JAMA*. 1994;272(11):853–858.
4. Als H, Gibes R. *Newborn Individualized Developmental Care and Assessment Program (NIDCAP): Training Guide*. Boston, Mass: Children's Hospital; 1986.
5. Als H. Toward a synactive theory of development: Promise for the assessment and support of infant individuality. *IMHJ*. 1982;3(4):229–243.
6. Als H. Individualized, family-focused developmental care for the very low-birthweight preterm infant in the NICU. In: Friedman SL, Sigman MD, eds. *The Psychological Development of Low Birthweight Children. Advances in Applied Developmental Psychology, vol 6*. Norwood, NJ: Ablex Publishing; 1992.
7. Als H, Gilkerson L, Duffy FN, McAnulty GB, Buehler D, Sell E, Vandenberg K, Sweet N. Medical, neurobehavioral and family outcome at two weeks post-term of a multi-site NICU trial of developmental care. In preparation.
8. Buehler DM, Als H, Duffy FA, McAnulty GB, Lieberman, J. Effectiveness of individualized developmental care for low risk preterm infants: Behavioral and electrophysiological evidence. *Pediatrics*, in press.
9. Tomm K. Interventive interviewing: Part III. Intending to ask lineal, circular, strategic, or reflexive questions? *Family Process*. 1988;27(1):1–15.
10. Zeichner KM. Alternative paradigms of teacher education. *J Teach Educ*. 1983;34(3):3–9.
11. Ross DD. Teaching teacher effectiveness research to students: First steps in developing a reflective approach to teaching. Paper presented at the Annual Meeting of the American Educational Research Association, Washington, DC; 1987.
12. Cruickshank DR, Holton J, Fay D, Williams J, Kennedy J, Myers B, Hough, J. *Reflective Teaching*. Bloomington, Ind: Phi Delta Kappa; 1981.
13. Schön DA. *The Reflective Practitioner: How Professionals Think in Action*. New York, NY: Basic Books; 1983.
14. Schön DA. *Educating the Reflective Practitioner*. San Francisco, Calif: Jossey-Bass; 1987.
15. Bowman B. Self-reflection as an element of professionalism. *Teachers College Record*. 1989;90(3):444–451.
16. Fenichel E. Zero to Three work group on supervision and mentorship: Learning through supervision and mentorship to support the development of infants, toddlers, and their families. In Fenichel E, ed. *Learning Through Supervision and Mentorship: A Source Book*. Arlington, Va: Zero to Three; 1992.
17. Tremmel R. Zen and the art of reflective practice in teacher education. *Harvard Educ Rev*. 1993;63(4):434–458.
18. Langer E. *Mindfulness*. Reading, MA: Addison-Wesley; 1989. Cited in Tremmel R. Zen and the art of reflective practice in teacher education. *Harvard Educ Rev*. 1993;63(4):434–458.
19. Als H. Data from the National Collaborative Research Institute. Conference presentation, Contemporary Forums Developmental Interventions in Neonatal Care. San Francisco, Calif, 1993.
20. Belenkey MF, Clinchy BM, Goldberger NR, Tarlue JM. *Women's Ways of Knowing: The Development of Self, Voice, and Mind*. New York, NY: Basic Books, 1986.
21. Shanok RS. The supervisory relationship: Integrator, resource, and guide. In Fenichel E, ed. *Learning Through Supervision and Mentorship: A Source Book*. Arlington, Va: Zero to Three; 1992.
22. Gilkerson L. Understanding institutional functioning style: A resource for hospital and early intervention collaboration. *Inf Young Children*. 1990;2(3):22–30.
23. Bettelheim B, Rosenfeld AA. *The Art of the Obvious: Developing Insight for Psychotherapy and Everyday Life*. New York, NY: Alfred A. Knopf; 1993.
24. Huse EF. *Organizational Development and Change*. 2nd ed. St. Paul, Minn: West Publishing Company; 1980.
25. Cooperrider DL, Srivastva S. Appreciative inquiry in organizational life. *Res Organ Change Dev*. 1987;1:129–169.
26. Gilkerson L. Taking the pulse: Understanding the dynamics of your unit. Conference presentation, Contemporary Forums Developmental Interventions in Neonatal Care Conference: San Francisco, Calif, 1993.
27. Shortell SM, Rousseau DM Gilles RR, Devers KJ, Simons TL. Organizational assessment in intensive care units (ICUs): Construct development, reliability, and validity of the ICU nurse-physician questionnaire. *Medical Care*. 1991;29(8):709–723.
28. Miller E. Developing a learning organization. Conference presentation. Chicago Center for the Study of Groups and Organizations; 1992.
29. Gilkerson L, Young-Holt CL. Supervision and the management of programs serving infants, toddlers and their families. In Fenichel E, ed. *Learning through Supervision and Mentorship: A Source Book*. Arlington, Va: Zero to Three; 1992.

APPENDIX F

ADDITIONAL INSTRUMENTS

1. Template Manual and Scoresheet
2. ABSO Manual and Scoresheet
3. Complexity Measures

Profile of the Nursery Environment and of Care Components

Template Manual, Part I

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Introduction

The following 5-point rating scales have been developed in an effort to document aspects of the physical environment and of the organization of caregiving which infant and family experience in the course of hospitalization. Nursery refers to NICU (newborn intensive care nursery), SCN (special care nursery), and/or other hospital nursery setting respectively.

Aspects of environment and care are measured on 5-point scales; a score of 1 reflects lack of consideration or misunderstanding of developmental opportunities; a score of 5 reflects a high degree of developmental sensitivity. NA (not applicable) is marked when the particular aspect is not available to be observed, or does not apply.

The scales are grouped into the following areas:

A. Physical environment of the nursery
B. Physical environment of the infants' bedspace
C. Specific aspects of direct infant care

Ratings are performed by a trained observer who has achieved reliability in the NIDCAP (Newborn Individualized Developmental Care and Assessment Program) methodology, and has established reliability with a designated NIDCAP trainer in the use of the templates. Template scoring is appropriate after a full NIDCAP observation. The parameters measured are rated as they relate to the specific infant observed and to that infant's family at the particular time point of that observation.

Appropriate uses of the template scales are documentation of change in the course of a nursery's adoption of developmental care as framework of care delivery; documentation of difference in care within nurseries, or across nurseries; examination of the relationship of environmental and caregiving parameters to infant, family, and staff functioning and satisfaction, and others

The scales have been developed in the context of the National Collaborative Research Institute on Early Childhood Intervention (NCRI-ECI) (1989–1994), entitled "Family-Focused, Individualized Developmental Care for the Very Low Birthweight Infant," funded by the U. S. Department of Education Office of Special Education Programs (OSEP), Early Education Programs for Children with Disabilities (EEPCD). The institute was directed by Dr. Heidelise Als and co-directed by Dr. Linda Gilkerson. The scales were systematically used at all five collaborating sites (4 NICUs and 1 SCN) in the context of weekly NIDCAP observations of the experimental group infants studied, in order to assess change in the course of the intervention phase. Additionally, they were used every six months in comparison of control and experimental group environments and care. The scales were found to be reliable as well as sensitive to temporal change and to group differences.

Part II of the Template Manual is currently under revision. It will provide scales yielding a profile of the organizational structures of a nursery. Included will be: I. Staffing aspects as they relate to direct infant care; II. Clinical management aspects; III. Staff composition, staff training, and staff support; IV. Family-related aspects; and V. Transition systems aspects.

Acknowledgments

We thank the principal investigators at the collaborating sites Dr. E. Sell, Ms. K. VandenBerg and N. Sweet, as well as their staff, for the diligent collection of the data at the Tucson and Oakland sites. We furthermore thank Ms. Deana DeMare for her dedication and skill in collecting, scoring, and coding the data from the Boston and outlying sites. We furthermore thank Ms. J. Cole, K. Daniels, and A. Farrell for their thoughtful contribution to the first draft of the scales.

A. Physical Environment of the Nursery*

1. Location in relation to labor and delivery floor and mother's postpartum room

(1) The Nursery is not in proximity to the Labor and Delivery Floor, nor to the mother's postpartum room.

(2) The Nursery is located adjacent to the Labor and Delivery Floor; the mother's postpartum room is in a separate location.

(3) The Nursery, Labor and Delivery Suite and the mother's' postpartum room are in close proximity to each other; yet accessibility of the Nursery for the postpartum mother is not assured.

(4) The Nursery, Labor and Delivery Suite and the mother's postpartum room are in close proximity to each other on the same floor; transport means (wheelchairs; moveable beds) for the postpartum mother are readily available and the mother may reach the infant's' bedside easily at any time.

(5) The Nursery, Labor and Delivery Suite and the mother's postpartum room are in close proximity to each other and on the same floor. Rooming-in facilities within the nursery at the infant's bedside are available for mother and infant.

2. Appearance

(1) The Nursery has a clinical appearance; walls and floors are plain and institutional; windows are bare or have institutional blinds only; fluorescent lighting is prevalent.

(2) The Nursery is clinical in appearance, some attempt is made to make the Nursery appear home-like, yet it is minimal: there may be an occasional picture or wall hanging, there may be a patterned curtain, or an occasional personal item at a bedspace, or a chair with a soft cushion.

(3) The Nursery has a moderately home-like appearance, while some aspects appear clinical: walls may be soft in color; some lighting may be indirect; the hallway leading to the nursery room may have pictures and home-like decor; there may be some individualization of the bedspace, and an occasional home-like chair; overall, the area appears nevertheless quite clinical.

(4) The Nursery has a definite home-like appearance: comfortable chairs are available to the parents; walls may have home-like wallpaper, borders, and pictures; curtains are on the windows; and lighting is indirect; individualization of bedspaces is

* Nursery refers to the observed infant's nursery environment or care room.

evident; and a reclining bed-chair is available at each bedside; the path to the infant from entrance to bedspace is friendly and welcoming.

(5) The Nursery has a definite home-like appearance in terms of furniture, color schemes and lighting. Furthermore, floors are carpeted; home-like lamps with dimmer switches provide individualized lighting for each bedspace; attractive plants are appealingly arranged and are well-tended; individualization of bedspace is consistently evident; furniture at the infant's bedspace is comfortable for the parents and professional caregivers' restful caring and nurturing of the infant (reclining, two-parent bed-chair; outgoing telephone line; side table for personal items).

3. Physical layout

(1) Space in the Nursery is very crowded. Housekeeping and medical equipment storage areas, secretarial station and staff sitting spaces are part of the same space as the infant's care area; family space at the bedside is essentially absent.

(2) The location of the infant care area provides some separation of the infant and family from other unit activities; a treatment or triage area may be designated within the Nursery space yet may be without a physical boundary; equipment storage areas appear separate; secretarial station and staff lounges may be only partially separated from the care area and/or doors separating them may remain open; utility and conference rooms may connect directly to the infant care spaces; family space at bedside is minimal.

(3) The location of the infant's care area from other activities provides considerable separation of infant and family from interference by other unit activities: the staff lounge may be located very close to the infant care area, etc. Family space at the bedside is available yet limited; a door to the hallway may be consistently open.

(4) There is thorough separation of the infant's care area from other unit activities. Infant and family are undisturbed by other unit activities: family space at the infant's care area is consistently available; there furthermore is a separate parent room available for the family at any time and the Nursery has an adequate number of parent rooms; there is an adequate changing and storage area for the family; equipment is stored away from the infant and the family; treatment or triage rooms, secretarial stations, utility and conference rooms are separate, which affords the infant and family a peaceful environment in the Nursery.

(5) Ample nursery space is available for infant and family free of interference from other unit activities. Complete and comfortable rooming-in facilities are available for the families in the infant's care room.

evident; and a reclining bed-chair is available at each bedside; the path to the infant from entrance to bedspace is friendly and welcoming.

(5) The Nursery has a definite home-like appearance in terms of furniture, color schemes and lighting. Furthermore, floors are carpeted; home-like lamps with dimmer switches provide individualized lighting for each bedspace; attractive plants are appealingly arranged and are well-tended; individualization of bedspace is consistently evident; furniture at the infant's bedspace is comfortable for the parents and professional caregivers' restful caring and nurturing of the infant (reclining, two-parent bed-chair; outgoing telephone line; side table for personal items).

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(5) Ample nursery space is available for infant and family free of interference from other unit activities. Complete and comfortable rooming-in facilities are available for the families in the infant's care room.

4. Density and size of bedside space

(1) The infant is in very close proximity to other infants. The parent or caregiver cannot easily fit a chair at the bedside.

(2) The infant is in very close proximity to the other infants, though it is possible to fit a chair for the parent or caregiver at the bedside; or there is enough space at the infant's bedside yet the infant is one of many infants cared for in one large, undivided room.

(3) There is enough bedspace for the infant and caregiver, yet more than six infants are cared for in the same nursery room.

(4) The infant's bedspace is one of 4–6 bedspaces in the nursery room; approximately 120 square feet are allotted for each infant and family; each infant clearly has a distinct space.

(5) The infant is cared for in a family-like, semi-private or private room setting with only 2–4 cribs in each spacious care area. There is ample space for each individual infant and family.

5. Design of bedside space

(1) Medical equipment appears to consistently interfere with accessibility to the infant; chairs are not consistently available at the bedspace, unused equipment is stored around the bedspace in the room.

(2) Medical equipment appears to some extent to interfere with accessibility to the infant; chairs are inconsistently available at the bedspace in the room; some unused equipment may be stored around the bedspaces.

(3) Medical equipment sometimes interferes with accessibility to the infant; chairs are available at most of the bedspaces in the room; unused equipment is largely stored away from the bedspaces.

(4) Medical equipment is well arranged, providing ready accessibility to the infant; a comfortable chair is available at the infant's bedspace, as well as at each of the other bedspaces; unused equipment is stored away from the bedspaces.

(5) Medical equipment is well integrated into the design of the bedspace. The room setting and furniture is family-like and semi-private or private.

6. Conduciveness for family participation

(1) Space is very limited. The parents of several infants cannot be in the room at the same time nor is there enough room for them to care for their infants.

(2) Several chairs and/or places for parent-infant interaction are available in the nursery at large, yet not in the infant's care room. A parent room is available for breast feeding and for parent-infant interaction when the infant is well enough.

(3) Chairs and space are available at the infant's bedspace. The bedspace may be partitioned off within the nursery room. A parent room is available when the infant is well enough.

(4) A large, comfortable chair that reclines or a bed-chair is available next to the infant's bedspace; more than one parent room is available. Overnight parent rooms are available for the families whose infants are well enough.

(5) The Nursery room is intimate, supportive, and home-like. A parent bed wide enough for both parents is part of the infant's bedspace. There is enough space and privacy for the parents to sleep , stay overnight, and care in skin-to-skin contact for their infant. A private telephone is installed at the bedspace for the family's personal use; smaller chairs are available for young siblings. There are private overnight rooms with bathroom facilities including showers for parents or families who are living-in with their infants.

7. Conduciveness for professional care components*

(1) On-call rooms, laboratories, staff offices, pharmacy, and staff changing rooms, lounges, and conference rooms are in separate and often distant areas of the hospital.

(2) One or two of the staff areas and/or support service areas are near the nursery space.

(3) Some of the support services and staff areas are near the nursery space.

(4) Most of the support services and staff areas are near the nursery space.

(5) Support services including laboratories and pharmacy, and staff areas including conference rooms, on-call rooms, and staff lounges are near the nursery space.

* This scale typically cannot be scored on the basis of a direct observation alone.

B. Physical Environment of the Infant's Bedspace

1. Light level

(1) The infant is cared for at all times in an environment with bright fluorescent overhead light and/or bright daylight.

(2) During rest periods, the infant is in somewhat muted light; a partial or thin blanket covering may be present over the infant's incubator or bed, or a partial blind is drawn at a window, though the room is generally bright.

(3) For periods, the infant is in semi-darkness; either thick, large blankets cover the entire incubator or crib; the infant's eyes may be shielded during alertness from bright overhead light, or the room is maintained at semi-dark level.

(4) During sleep, the infant is in nearly complete darkness. During alert periods, controlled indirect lighting provides an overall semi-dark environment.

(5) The infant is in darkness during sleep and there are appropriate levels of light for alertness. Adjustments are titered to the individual infant's developmental progress toward increasing robustness and self-regulation. Individual bedspace lighting with dimmer capacity is used throughout the care room. Lighting is indirect and is controllable by the parent as well as the staff.

2. Sound level

(1) Loud human voice and environmental sounds are heard at the infant's bedspace at all times: staff voices, frequent crying sounds from nearby infants, overhead speaker systems, telephone and alarms ringing, sound from the secretarial station, water rushing, doors, equipment and supply sounds, etc.

(2) Loud human voice and environmental sounds are heard at the infant's bedspace much of the time; fluctuations may occur between soft whispering and louder voices; radio, waste receptacles, and sink sounds are clearly heard, as well as sounds from the secretarial station, hallway, etc.

(3) Loud human voice and environmental sounds are heard some of the time; at times human voices are held at soft levels; a radio may be heard at a low level; a sink may be used relatively quietly.

(4) Human voice and environmental sounds are kept to a minimum. Very low levels of sound are present. There appears to be felt stripping on waste receptacles and drawers. Incubator portholes and cupboard doors are closed quietly; equipment is moved quietly. Ambient staff voices are very soft. There is no radio; alarms are

muted. Proximity to faucets and sinks, x-ray screens, telephone, and staff movement is avoided or their use is muted and quiet.

(5) Sounds are consistently very low. Walls appear sound-reducing and absorbing. Monitors and telephones are on the lowest settings and with very soft rings, backing-up light and vibrating alarms. Staff voices are very quiet. Rounds occur away from the bedside. Overall, the infant's care area is peaceful and quiet.

3. Activity level

(1) The nursery atmosphere is hectic with continuously changing activity, visitors, staff, technical and laboratory personnel hurrying about, water running, doors opening and closing and equipment being moved.

(2) Activity levels are quite high, though at times subsiding to lower intensities.

(3) Activity levels are moderately low. There appear to be efforts to move activity away from the infant's bedspace, although this appears to be inconsistent.

(4) A calm, quiet nursery atmosphere is largely present; an exception may be an emergency situation.

(5) A very calm, quiet, and soothing atmosphere is consistently present. Emergency situations are handled with an activity containing protocol.

4. Visual array inside of incubator/crib space

(1) A complex and dense array of visual stimuli is continuously present on the walls of the crib or incubator; it may include numerous or intensely-patterned (e.g., black and white checkerboard) toys and mobiles continuously within the infant's immediate visual field; or the infant's visual space is filled with equipment and bedding only, without apparent consideration of the infant's visual experience or state organization; or the infant's visual field is barren and essentially devoid of texture, form, and color.

(2) Many visual inputs are continuously present within the infant's immediate visual field, be they equipment or toys, mobiles, etc.; or the infant's visual space is nearly devoid of all texture, form, and color.

(3) Several visual stimuli are continuously present within the infant's immediate visual field.

(4) Visual stimuli are provided, including the parents and/or professional caregiver's face, when the infant is alerting. They are muted or removed from the infant's

visual field when the infant becomes drowsy, is going to sleep, or becomes hyper-alert or upset.

(5) Differential visual stimuli, including the parents and/or professional caregiver's face, are provided, muted, and removed in support of the infant's state and self-regulatory robustness.

5. Olfactory inputs

(1) Noxious odors are frequently present in the infant's immediate olfactory field, e.g., alcohol wipes, adhesive remover, cleaning fluids, recent painting, caregivers' perfumes, cooking odors; soiled clothing; rubber tubings, gloves, equipment and disposable staff gowns. Familial and comforting odors, such as the mother's breast and body scent, the father's body scent, are absent.

(2) Noxious odors are periodically present in the infant's immediate olfactory field; familial, comforting odors are available when the parents are near the infant.

(3) Noxious odors are infrequently present in the infant's immediate olfactory field; familial, comforting odors are available when the parents hold the infant.

(4) Noxious odors are actively eliminated from the infant's immediate olfactory field whenever possible; a familial, comforting olfactory environment is provided for some of the time also when the infant is in the incubator or crib by providing the mother's breast pad, a blanket cloth, or piece of clothing the mother or father have worn or held on their body.

(5) A consistent familial olfactory environment of the parent's body scent is provided for the infant at all times.

6. Bedding and clothing

(1) Bedding and clothing are unrelated to the infant's individual needs or preferences; the infant may be unclothed and uncovered, and may be lying on a flat bedding surface; or the infant wears a disproportionately large diaper, or is completely and very tightly swaddled.

(2) Bedding and clothing are somewhat related to the infant's preferences and needs, e.g., the infant may be swaddled once cared for; however, swaddling may be tight or routinely applied; the infant's diaper and clothing may be too large for the infant; some nesting and boundaries may be used, apparently routinely.

(3) Bedding and clothing are in general related to the infant's preferences and needs, yet this is inconsistent, e.g., the infant may wear a hat and socks and has a foot roll,

although it is not clear how these relate to the infant's organization. Holding of the infant by the parents for limited periods may be considered appropriate.

(4) Bedding and clothing are consistently related to the infant's preferences and needs and are individualized. This includes provision of options such as water mattress, sheepskin, boundaries, "nesting," clothing with soft one-piece suits, soft hat, gentle swaddling, and appropriately bedding the infant, and/or providing skin-to-skin holding by the parents for extended periods.

(5) Bedding and clothing is creatively individualized to suit the infant's needs; this includes the option of a bunting, hammock, huggel suckel, and/or huggel visor, as well as other individualized materials supportive of the infant, such as an appropriately soft and small diapers, well-fitting, soft clothing, and soft cover blankets. The parent is seen as the infant's most well-aligned bed; rooming-in with the infant is encouraged.

7. Specific self-regulatory aids

(1) Self-regulatory aids and use of buntings and pacifiers; being held by the parents or caregiver; human facilitation of containment and hand swaddling; opportunity to suckle on the parent's breast and/or caregiver's finger; are absent.

(2) Self-regulatory aids are occasionally or sporadically used.

(3) Self-regulatory aids are used frequently, yet uniformly and routinely. The parent is encouraged at times to provide regulation.

(4) Self-regulatory aids are used frequently and in an individualized fashion, including holding, human facilitations with hand swaddling, caressing, and containment, opportunities to suck during and between procedures such as gavage feedings; and to hold on during manipulations, using the caregiver's finger, bedding, foot rolls, and buntings. The parents are seen as the infant's best regulators. The professional caregiver encourages the parents' regulatory collaboration.

(5) Self regulatory aids are used consistently, and in an individualized fashion, This includes consistent parent skin-to-skin facilitation, and extensive holding and regulation by the professional caregiver when the parent is not in a position to be with the infant.

C. Specific Aspects of Direct Infant Care

1. Positioning

(1) Supine, prone, or side-lying positioning are used uniformly without facilitation of shoulder and hip flexion. When the infant is held, physiological alignment of head, trunk, and limbs is not considered.

(2) Minimal facilitation of the infant's shoulder and hip flexion is provided in side-lying, prone, and supine positioning; when held, minimal alignment of head, trunk, and limbs is provided, with some adjustment of shoulder and hip flexion.

(3) Individualized, physiologically well-aligned positioning is used intermittently, e.g., for sleep transitions. The parent is supported at times to facilitate the infant's position when the infant is in the incubator or crib and/or when held.

(4) Individualized, physiologically well-aligned positioning is used consistently when the infant is held and when bedded on the parent and/or in the incubator or crib, and during most procedures.

(5) Individualized, physiologically well-aligned positioning is used, supported, and facilitated throughout, including routine and specialized procedures (e.g., EEG, head ultrasounds, etc.) and in between caregiving interventions when held, bedded on the parent, and/or in the incubator or crib.

2. Feeding (gavage/breast/bottle)

(1) Arrangements made prior to, during, and after feeding do not include equipment, room temperature, lighting, and sound preparation, nor state preparation, positioning and facilitation; nor caregiver attentiveness, and emotional availability. Gavage feedings may be hung inside the incubator while the infant remains in prone position throughout the feeding and the caregiver leaves the bedside; or the room may be cold and loud when the infant is held for a feeding.

(2) Some arrangements are made prior to, during, and after feeding in terms of equipment, room temperature, lighting and sound, state preparation and facilitation, positioning, caregiver attentiveness, and emotional availability; they may be minimal. The infant may be partially shielded from light and sound; the room may be marginally warm enough, the caregiver may be emotionally and attentionally attuned some of the time; some adjustment of the infant's positioning may be observed. The infant's hands are typically not freed or included in the feeding facilitation. The parent may be allowed to feed the infant and breast feeding may be considered as an option.

(3) Significant arrangements are made prior to, during, and after feeding in terms of state preparation and facilitation, positioning, equipment, room lighting, sound and temperature, and in terms of caregiver attentiveness, and emotional availability; they may be inconsistent or not individualized. The infant may be shielded from light; the sound level may be muted and the room warm enough; the infant's position may be supported in advance of the feeding, however, the caregiver may provide little consistent support throughout or following feeding. The hands of the infant may only be partially freed, supported, and engaged in the feeding. The parent may be encouraged to feed the infant and breast feeding may be valued to some degree.

(4) Significant and thoughtful arrangements are made prior to, during, and after feeding in terms of equipment, room lighting, sound and temperature, and in terms of state preparation and facilitation, positioning, caregiver attentiveness and emotional availability. Facilitation is consistently employed. The infant's behavioral cues and states are considered and supported; the feeding is performed calmly and in an emotionally nurturant way; feeding is initiated once the infant is statewise and positionally facilitated to readiness. Timing and pacing of feeding is titered carefully to the infant's robustness and availability. The infant's hands are consistently engaged in holding on during the feeding. A pacifier may be provided, if deemed supportive. The parent is encouraged and supported as the infant's appropriate provider of nourishment and nurturance. Breast feeding is valued and encouraged.

(5) Infant-initiated (demand) feeding in coordination with the infant's state cycle is aimed for and supported. The room is calm, warm, and muted in lighting. The infant is supportively held and positioned comfortably prior to feeding, snuggled in the caregiver's arms, resting against the caregiver's chest. The infant's hands are supported to grasp as part of the pleasure of feeding. During feeding the infant is provided with calm, gentle, human containment and facilitation. Pacing of feeding is determined by the infant's cues and initiative. As indicated, rests are built in. A pleasurable, satisfying, nurturant experience is the goal. After feeding, support continues in order to ensure the infant's well-maintained regulation and smooth transition back to sleep. The parent is considered the infant's most important provider of nutrition and nurturance.

3. Burping

(1) The infant receives repeated vigorous back patting or rubbing in the course of feeding on an apparently fixed-interval schedule regardless of the infant's cues. The infant may be held sitting upright, supported under the chin or the back of the head only, with arms hanging loosely or extended, or laid across the caregiver's lap for burping. Prevention of soiling of the shift or blanket and use of a spilling cloth may be an over-riding focus. The infant may be tightly swaddled or be without any containment. The infant may receive simultaneously a number of visual and

auditory stimuli. The caregiver may appear distracted and preoccupied with other thoughts most of the time.

(2) Vigorous back patting or rubbing occurs repeatedly in the course of feeding, apparently unrelated to the infant's cues; position supports are minimal, environmental stimulation is moderate. The caregiver may appear preoccupied with other issues much of the time, or focus largely on the adjustment of the bib or spitting cloth.

(3) Combinations of moderate back patting and rubbing are used, environmental stimulation is muted. Burping actions may be timed partly in relation to the burst-pause sucking pattern of the infant, and are performed relatively gently.

(4) Burping, when indicated by the infant, is supported by gentle upright positioning on the caregiver's chest or shoulder, perhaps gentle walking. The parent is perceived as the infant's most appropriate provider of feedings, and is encouraged to gently burp the infant as indicated by the infant's cues.

(5) Burping is facilitated by gentle positioning on the caregiver's shoulder, is always performed softly and slowly. The position is timed to the infant's cues and relaxation is always aimed for. The parent is nurtured as the infant's most important provider of feeding and burping.

4. Diaper changing and skin care

(1) Arrangements prior to, during and after diaper changes and skin care do not include equipment or room preparation, in terms of lighting, sound, and temperature, nor state preparation, positioning, caregiver attentiveness, and emotional availability. The infant is usually in an unsupported position during diaper change and skin care.

(2) Partial arrangements are made prior to, during, and after diaper change and skin care in terms of equipment and room preparation and in terms of state preparation, positioning, caregiver attentiveness, and emotional availability. The procedures may be performed with the infant in side-lying or prone position but without postural support.

(3) Moderately effective arrangements are made prior to, during, and after diaper change and skin care in terms of state preparation, positioning, lighting, staff attentiveness, and emotional availability. Diaper change and skin care may be performed in supine, side-lying, or prone, yet facilitation provided. The materials used are partially appropriately in size, texture, and shape for the infant's comfort. The parent is encouraged to participate in diaper change and skin care.

(4) Significantly effective arrangements are made prior to, during, and after diaper change and skin care in terms of equipment and room preparation, and in terms of state preparation, positioning, caregiver attentiveness, and emotional availability. Diaper changing and skin care are accomplished with the infant bedded in a supported prone, side-lying position or supine position. The parent is supported in participating in or performing diaper change and skin care; flexor support and self regulatory aids are provided before, during, and following the care procedures. The materials used are quite appropriate in size, texture, and shape for the infant's comfort.

(5) Individualized and highly infant-attuned arrangements are made prior to, during, and after diaper change and skin care in terms of equipment and room preparation, state preparation, positioning, caregiver attentiveness, and emotional availability. Diaper changing and skin care are accomplished with the infant bedded comfortably with effective flexor support and self regulatory aids provided before, during, and following the care procedures. The caregiver assures a calm, soothing atmosphere, while gently containing and supporting the infant. The materials used are soft, attractive, and appropriate in size, texture, and shape for the infant's comfort. The parent is valued as the most appropriate person to change the infant's diaper and provide skin care. The professional caregiver assists the parent as indicated.

5. Bathing

(1) No arrangements are made prior to, during, and after bathing in terms of equipment, room temperature, sound and lighting, and in terms of state preparation, positioning, caregiver attentiveness, and emotional availability. Sponge, tub, or sink bathing in supine positioning is given without support to the infant's regulation.

(2) Minimal arrangements are made prior to, during, and after bathing in terms of equipment, room temperature, sound and lighting, and in terms of state preparation, positioning, caregiver attentiveness, and emotional availability. The infant may be partially shielded from light; the caregiver may be engaged some of the time; some adjustment of the infant's positioning may be observed. Some flexor support may be given during sponge, tub, or sink bath. The parent is marginally included in bathing the infant.

(3) Moderate arrangements are made prior to, during, and after bathing in terms of equipment, room temperature, sound and lighting, and in terms of state preparation, positioning, caregiver attentiveness, and emotional availability, but they are inconsistent or not individualized. The infant may be shielded from light; the sound level may be low and the room warm enough; the infant's position may be supported in advance of the bathing, however, the caregiver may provide little direct support throughout, or following bathing. Bathing may be individualized in frequency and timing, some flexor support may be given with partial immersion in water. The parent may be encouraged to participate in bathing the infant.

(4) Significant arrangements are made prior to, during and after bathing in terms of equipment, room temperature, sound and lighting, and in terms of state preparation, positioning, caregiver attentiveness, and emotional availability. The infant's behavioral cues and states are considered; the bathing is performed calmly and gently. Bathing is initiated once the infant is statewise and positionally facilitated and ready. A pacifier may be provided, if deemed supportive. Bathing is individualized in frequency and timing. Deep, warm water for immersion bath may be used. The infant may be lowered into the bath swaddled in a blanket. The parents are considered the best bathers for the infant.

(5) The infant is supportively positioned and contained prior to bathing. The room is calm, soothingly lighted, and warm. During bathing the infant is provided with calm, gentle, human and blanket containment as indicated. After bathing support continues in order to ensure the infant's smooth state transition and well-maintained self-regulation. Parent and infant may bathe together in the privacy of family nursery suite. Bathing is a pleasurable family experience.

6. Timing and sequencing of caregiving interactions

(1) Care procedures and interactions are implemented on a fixed nursery schedule without consideration of the infant's states and organization; sleep is interrupted; caregiving interactions are interrupted in order to obtain necessary equipment (stethoscope, thermometer, diapers, etc.) or to rearrange space. The parent is excluded as possible facilitator of the infant.

(2) Care procedures and interactions are implemented with some consideration of the infant's states and organization. An occasional arrangement is made for the scheduling of a procedure in consideration of the infant's sleep cycle. Basic equipment (stethoscope, thermometer, diapers, etc.) may be placed at the bedside prior to caregiving thus reducing interruptions during caregiving. Overall, a fixed nursery-based schedule is maintained. The parent features minimally in structuring and facilitating care procedures for the infant.

(3) Care procedures and interactions are inconsistently individualized in terms of the infant's states and organization. Procedures are at times grouped into clusters and within a caregiving session manipulations are sequenced to minimize stress; equipment and space are largely prepared prior to caregiving interactions. The parents are included to some extent in planning caregiving procedures and in facilitating the infant.

(4) Care procedures and interactions are individualized and consistently implemented with consideration of the infant's states and organization. Caregiving interactions are timed to promote developmentally appropriate periods of uninterrupted sleep and of robust awakeness. Procedures are clustered as individually supportive . The

caregiver assesses each interaction in order to determine appropriate timing and pacing. The parent is supported as the most important regulator of the infant.

(5) The infant's sleep-wake cycle, feeding robustness, and other emerging competencies are considered foremost when timing of caregiving, including interventions of consulting specialties such as ophthalmology, neurology, ultrasound, X-ray, etc., is planned. The parent is valued as the infant's foremost regulator in the course of procedures. Enhancement of the infant's sense of pleasure and pride is an important goal.

7. Transition facilitation

(1) Care procedures and interactions are performed with consideration of staff schedules. Preparation of room lighting, sound and temperature, the infant's state readiness and positioning, assurance of the caregiver's attentiveness and emotional availability are not apparent.

(2) Care procedures and interactions are at times performed with some preparation of the room lighting, sound and temperature, preparation of the infant's state readiness and positioning, and assurance of the caregiver's attentiveness and emotional availability. The infant may be partially shielded from light, the caregiver may be emotionally engaged some of the time; some adjustment of the infant's positioning is observed. The parent features minimally in providing transition facilitation.

(3) Care procedures and interactions are performed frequently with some preparation of room lighting, sound and temperature, preparation of the infant's state readiness and positioning, and the assurance of the caregiver's attentiveness and emotional availability. This may be at times inconsistent and not necessarily individualized; the infant may be shielded from light; the sound level may be kept minimal and the room may be warm; the infant's position may be supported in advance of care procedures and interactions; however, the caregiver may provide little direct support throughout, or following procedures and interactions; or some degree of facilitation may be given fairly consistently yet it may be removed before the infant is fully settled, restful, and comfortable. The parent may be encouraged to provide some facilitation.

(4) Preparations are made prior to, during and after care procedures and interactions in terms of room lighting, sound and temperature, in terms of supporting the infant's state readiness and positioning, and assurance of the caregiver's attentiveness and emotional availability. These preparations are consistently employed and are based on the infant's individual cues. Prior to necessary procedures and interactions the infant may be assisted in maintaining flexion, provided an opportunity for sucking, and shielded from unnecessary interruptions and stress. Procedures are performed efficiently and with ongoing support to the infant. After procedures, unhurried reorganization takes place, including flexor support, opportunities for holding on

and sucking as indicated. Extraneous stimulation e.g., stroking, talking, position shifts, etc. is avoided and the infant is supported to become well regulated; then removal of one supportive aid at a time is attempted. As much time as needed is taken to assure re-regulation of the infant. The parents are supported as the infant's important transitions facilitators.

(5) The infant is supportively positioned and stabilized prior to all care procedures and interactions. During procedures the infant is provided with calm, gentle, containment and facilitation. Afterwards support continues in order to ensure the infant's smooth state transition and well-maintained self regulation. If needed, the caregiver may plan and integrate assistance from a second caregiver in order to assure maximally effective facilitation for the infant. The parent is valued as the infant's most reliable and effective facilitator.

8. State organization

(1) Caregiving interventions are timed and performed with attention to staff schedules. Consideration of the infant's state organization is not a factor. The infant may be frequently and/or abruptly awakened and/or left unfacilitated when crying or unsupported and unresponded to when awake. The parent is not included as regulator of the infant's state organization.

(2) Partial and inconsistent attention is given to the infant's state when timing and performing caregiving interventions. Flexor support may be used sporadically to enhance calmness. Interruptions of sleep and alert states may be limited, yet when occurring they are abrupt and without transition facilitation. The parent is encouraged minimally as regulator of the infant's state organization.

(3) Significant yet at times inconsistent or partially individualized attention is given to the infant's state. The infant is protected from disturbance when in deep sleep; when more awake the infant is provided with some support for calm state regulation by position facilitation during and after caregiving. Facilitation of transition back into sleep and/or enhancement of calm alertness may be occasionally observed. The parent is included to some extent in the facilitation of the infant's state.

(4) Consistent attention is given to the infant's state organization. The infant's deep sleep states and organization of sleep are supported by the maintenance of a calm predictable environment and schedule. The caregiver gently and consistently assists the infant in coming to alertness, in maintaining modulated calm alertness and in returning to sleep. The parent is encouraged to participate in the facilitation of the infant's state regulation.

(5) Consistent, fully individualized attention and support of the infant's emerging and increasingly autonomous state regulation is observed. The caregiver establishes a reliable support pattern of gradual transition facilitation into and out of sleep. Sleep

maintenance and enhancement of alertness are supported. The caregiver utilizes hand caressing and swaddling, holding, boundaries, perhaps a hammock or gentle music, as indicated. All supports are carefully adjusted to the infant's increasing self-regulation. The parent is nurtured and valued as the infant's foremost state regulator.

9. Organization of alertness by use of environmental inputs

(1) Intense light and sound consistently impinge upon the infant. Pleasing sounds and sights are absent. Intense auditory and visual stimuli are provided at all times. The infant's threshold to calm alert state maintenance is not considered. The parent is not involved as an appropriate facilitator of the infant's alert state.

(2) Minimal or sporadic protection from light and sound is provided in an apparent effort to facilitate the infant's alert state: e.g., a light blanket may cover the incubator or the room light is reduced at times. When the infant attempts to open the eyes, the caregiver may comment on it, yet visual and auditory stimuli are provided inconsistently and without consideration of the infant's alert state regulation. The parent is minimally included in the facilitation of the infant's alert state.

(3) A moderate amount of protection from light and sound is given in an apparent effort to facilitate alertness. The infant's incubator may be fully covered with a blanket or the room lighting may be significantly reduced when the infant comes to an alert state. Some attempts are made to reduce sound levels around the infant's bedside during alert periods. An occasional pleasing visual and/or auditory stimulus is provided when the infant is alert. The parent is at times encouraged to facilitate the infant's alert state.

(4) Considerable protection from light and sound is consistently provided in order to facilitate alertness. The incubator may be well covered, room lighting consistently adjusted and/or the infant's eyes shielded when out of the incubator, environmental sound is kept to a minimum. Individually pleasing and supportive visual and auditory stimuli are provided intermittently. The parent is consistently encouraged to support the infant's alert state.

(5) Consistent protection from light and sound is provided in order to facilitate alertness. Individually pleasing, familially-chosen visual and auditory stimuli are provided in an individually appropriately timed fashion to support and enhance pleasurable alert experiences and facilitate increasing autonomy and initiation of the alert experience. The parents are valued as the most important nurturers of the infant's alert state.

10. Organization of alertness by the use of social inputs

(1) Timing, kind, complexity and intensity of social interaction provided to the infant is based solely on the caregiver's schedule and needs. No consideration is given to the infant's state organization, availability, receptivity and modulation. The parent is not included in social contact with the infant.

(2) Timing, kind, complexity and intensity of social interaction provided to the infant is largely based on the caregiver's schedule and needs. Some consideration is given to the infant's state levels and their modulation. The parent is minimally included in providing social facilitation of the infant's alertness.

(3) Timing, kind, complexity and intensity of social interaction provided is at times specifically geared to support the infant's alert state and it's modulation. The parent is intermittently encouraged to participate in the support of the infant's alert state.

(4) Timing, kind, complexity and intensity of social interaction provided is consistently adjusted to be supportive of the infant's alert state. Thorough consideration is given consistently to state levels and their modulation during social interaction. Interactions are timed in support of increasing stability of the infant's transition into a state of alertness. The infant is not disturbed if in a quiet sleep, and when in a quiet alert state social interaction proceeds in a softly modulated manner supporting reciprocity with the infant. The parent is consistently encouraged to support the infant's alert state.

(5) Timing, kind, complexity and intensity of social interaction provided is consistently individualized and supportive of increasingly robust and modulated alertness by the infant. Infant initiation and timing of reciprocal social interaction is consistently supported and enhanced. Joyful, pleasurable interactions are assured by consistently individualized and modulated reciprocation. The parents are valued as the most important nurturers of the infant's alert state.

Infant's Name _____ Hospital/Level _____
Date _____ Caregiver _____
Time _____ Discipline _____
Medical Record # _____ Room/Nursery Census _____
Other Notes Acuity/Room Census _____
Observer(s) _____

Profile of the Nursery Environment and of Care Components
Template Score Sheet — Part I

A. Physical environment of the nursery

1. Location in relation to Labor and Delivery Floor and Mother's Postpartum Room	1	2	3	4	5	NA
2. Appearance	1	2	3	4	5	NA
3. Physical Layout	1	2	3	4	5	NA
4. Density and Size of Bedside Space	1	2	3	4	5	NA
5. Design of Bedside Space	1	2	3	4	5	NA
6. Conduciveness to Enhance Family Participation	1	2	3	4	5	NA
7. Conduciveness to Enhance Professional Care Components	1	2	3	4	5	NA

B. Physical Environment of the Infant's Bedspace

1. Light Level	1	2	3	4	5	NA
2. Sound Level	1	2	3	4	5	NA
3. Activity Level	1	2	3	4	5	NA
4. Visual Array Inside of Incubator/Crib Space	1	2	3	4	5	NA
5. Olfactory Inputs	1	2	3	4	5	NA
6. Bedding and Clothing	1	2	3	4	5	NA
7. Specific Self-Regulatory Aids	1	2	3	4	5	NA

Infant's Name _____ Hospital/Level_____
Date_____

C. Specific Aspects of Direct Infant Care

1. Positioning	1	2	3	4	5	NA
2. Feeding (Gavage/Breast/Bottle)	1	2	3	4	5	NA
3. Burping	1	2	3	4	5	NA
4. Diaper Changing and Skin Care	1	2	3	4	5	NA
5. Bathing	1	2	3	4	5	NA
6. Timing and Sequencing of Caregiving Interactions	1	2	3	4	5	NA
7. Transition Facilitation	1	2	3	4	5	NA
8. State Organization	1	2	3	4	5	NA
9. Organization of Alertness by Environmental Inputs	1	2	3	4	5	NA
10. Organization of Alertness by Social Inputs	1	2	3	4	5	NA

Assessment of Behavioral Systems Organization Following Observation (ABSO)

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Assessment of Behavioral Systems Organization Following Observation (ABSO)

Introduction

After a behavioral observation using the NIDCAP (Newborn Individualized Developmental Care and Assessment Program) methodology of an infant before, during, and following caregiving or a medical procedure or interaction, the infant's behavioral functioning may be assessed in summary form by use of the APIB (Assessment of Preterm Infants' Behavior, Als et al., 1982) 9-Point Systems Scales. Additionally, the interactor's or caregiver's behavior may be scored on a 9-point caregiver effectiveness scale. For each behavioral system, a separate score is given for the time *before* the direct interaction or caregiving observed, the time *during* the direct interaction or caregiving observed, and the time *after* the direct interaction or caregiving observed. For the State System, additionally the actual states observed are in the order recorded and ranked as to their predominance. Following is a manual largely adapted from the APIB (Als et al., 1982) and modified as necessary for the scoring on 9-point scales of the Autonomic System, the Motor System, the State System, the Attentional System, the Regulatory System, and the infant's Need For and Use of Caregiver Facilitation. An additional scale has been developed in order to quantify the degree of Effectiveness of Caregiver Facilitation provided. It is also defined on a 9-point continuum, in parallel to the other scales.

For the Autonomic and Motor Systems, the APIB score definitions are used from the APIB Manual, currently under revision. For the State System, the translation from the actual states observed into scaled state scores, utilized in the APIB, is modified to be appropriate to states occurring in a caregiving situation, rather than a formal examination. On the ABSO score sheet, the space below the scores provided for the State System score itself is used for the re-ordering of all states in the order in which they are observed. In the shaded space below, the order of predominance is marked. For the Attentional System, the APIB scoring definitions are used largely unchanged, with score point 9 modified slightly to be appropriate to the naturalistic observation situation. The introductory paragraph to the Attentional System Scale is also modified, since, again, attention is not necessarily an actively strived for goal in the course of a caregiving observed. For the Self-Regulation System, the revised APIB score definitions are used largely unchanged from the revised APIB manual. The introductory paragraph is modified. The Examiner Facilitation scale from the APIB manual is revised and retitled Need for and Use of Caregiver Facilitation in order to capture the degree of facilitation apparently needed and the success inferred from the infant's observed behavior, as the facilitation is forthcoming, or if it were forthcoming. This will permit scoring not only of situations where the interactor is sensitively facilitative of the infant, but also of those where this is not the case. The Effectiveness of Caregiver Facilitation scale is devised in order to record the sensitivity and effectiveness the caregiver or interactor displays in supporting the regulatory and organizational efforts the infant shows. Training in the NIDCAP methodology and APIB are prerequisite for the use of the ABSO.

ABSO Scales

I. Autonomic System

Behavioral indices of the autonomic system assessed by observation are the infant's respiratory pattern, skin color, autonomically mediated movements such as tremors, startles, autonomic eye movements such as eye floating and eye rolling, sounds such as sighs and whimpers, and behavioral indices of visceral control such as hiccoughing, spitting up, gagging, bowel movement straining and grunting. The intensity or severity of the signs present, not their absolute number, is decisive in the assignment of a particular score. As in APIB scoring, the dimension of autonomic functioning which shows the greatest degree of disorganization determines the score, be it the respiration pattern, the color modulation, or the visceral system.

Scoring

1. Smooth regular respirations and heart rate, if assessed, good healthy color, no spontaneous tremors or startles, no facial twitches or autonomically-based eye movement disorganization, no signs of upset visceral response.

2. Very mild respiratory irregularity, very mild cyanosis, paleness, webbing or flushing, mild occasional tremors or startles, occasional mild facial twitches, sighs or whimpers, possibly a hiccough or mild gag.

3. Mild respiratory unevenness, mild respiratory pauses (2–3 sec.) and/or mildly speeded-up respirations, mild cyanosis, paleness, webbing or flushing, some tremors or startles, facial twitches, autonomically-based floating eye movements, some mild gagging, whimpering, or occasional hiccough.

4. Mild to moderate respiratory unevenness, mild to moderate respiratory pauses (3–4 sec.) and/or episodes of mildly to moderately speeded-up respirations, mild to moderate cyanosis, paleness, webbing or flushing, and/or mild to moderate tremors or startles, repeated facial twitches, autonomically-based floating eye movements, gagging, hiccoughing, bowel movement straining, or whimpering.

5. Moderate respiratory unevenness, i.e., moderate respiratory pauses (4–5 sec.), or moderately speeded-up respiration, moderate cyanosis, paleness, webbing or flushing, moderate degree of tremors and startles, and/or moderate facial twitches, autonomically-based floating eye movement, whimpers, hiccoughing, gagging, spitting up, or bowel movement straining.

6. Moderate to considerable respiratory unevenness, moderate to considerable respiratory pauses (5–6 sec.) and/or speeded-up respirations, moderate to considerable cyanosis, paleness, webbing, or flushing, moderate to considerable degree of tremors and/or startles, moderate to considerable facial twitches and autonomically-based floating eye movements, whimpers, hiccoughing, gagging, spitting up, or bowel movement straining.

7. Considerable respiratory unevenness, and/or considerable respiratory pauses (6–7 sec.) and/or considerably speeded-up respirations, considerable cyanosis, paleness, webbing or flushing, considerable degree of tremors and/or startles, considerable facial twitches, autonomically-based eye movement disorganization, hiccoughing, whimpers, gagging, spitting up or bowel movement straining.

8. Quite severe respiratory unevenness, respiratory pauses (7–8 sec.) and/or quite severely speeded-up respirations, quite severe cyanosis, duskiness, paleness, webbing or flushing, quite severe degree of facial twitches, autonomically-based eye movement disorganization, whimpers, hiccoughing, gagging, spitting up and/or bowel movement straining.

9. Severe respiratory pauses (greater than 8 sec.) with retraction or severe nasal flaring, or severely speeded-up respirations and/or severe duskiness, paleness, or very webbed or flushed red color, severe degree of tremors and/or severe facial twitches, and/or severe degree of autonomically-based eye movement disorganization.

II. Motor System

Behavioral indices of the motor system assessed by observation are reflected in the infant's posture, movements, tonus, and amount and degree of differentiation of activity. As for the autonomic system, the motor system dimension showing most disorganization determines the score given.

Scoring

1. Consistently smooth, well-modulated controlled posture. If movement, smooth postural changes and adjustments, well-modulated smooth movements of the extremities and head, well-modulated consistent tone throughout the body, well-modulated amount of smooth activity with well differentiated hand, arm, and leg movements.

2. Largely well-modulated and controlled posture. If movement, almost consistently modulated tone; no sudden arm or leg extensions; activity is predominantly modulated, and hand, arm and leg movements are moderately well differentiated. Disorganization is incidental.

3. Predominantly well-modulated and controlled posture, movement patterns and tone maintenance. Only briefly, and then mildly flaccid, overly flexed or extended posture. If movement, considerable periods of modulated controlled posture, only occasional fluctuations to very mild over-extension or flexion, only an occasional mild arm or leg extension (salute), tone largely consistently modulated with only very mildly hypertonic or very mildly hypotonic episodes, only very brief periods of very mildly frantic or diffuse activity, only an occasional generalized whole arm and leg movement.

4. Mildly to moderately frequently flaccid, mildly to moderately overly flexed or extended posture, embedded in considerable periods of modulated posture. If movement, moderate periods of modulated controlled movement alternating with brief episodes of

hyperextension and/or hyperflexion, mild or infrequent arm and leg extensions (salute) into midair; tone only occasionally fluctuating between mildly to moderately hypertonic or hypotonic, while mainly consistently well modulated. Infrequent periods of frantic or diffuse activity, infrequent sudden arm or leg movements.

5. Moderately long periods of moderately flaccid, overly flexed, or extended posture embedded in moderately long periods of modulated posture. If movement, occasional periods of modulated flexed posture alternating with episodes of hyperextension and hyperflexion in fluctuation, occasional moderate arm and leg extensions into midair (salute), tone moderately hypertonic or moderately flaccid for moderate periods, while modulated at other times. Occasional periods of frantic diffuse movement, occasional undifferentiated whole arm and leg movements embedded in periods of modulated activity.

6. Moderately to considerably flaccid, overly flexed, or extended posture with very brief periods of modulated posture. If movement, some fluctuation of hyperextended posture and hyperflexed posture, very brief periods of modulated flexion, occasional sudden, abrupt changes and adjustments. Some amount of jerky movements with several dramatic arm and leg extensions into midair (salute), tone somewhat variable periods of frantic, diffuse activity, some undifferentiated whole arm and leg movements, yet also brief periods of modulated tone and/or movement.

7. Considerably hyperextended or hyperflexed posture. If movement, moderate fluctuation of hyperextended posture and hyperflexed posture with sudden abrupt changes and adjustments; jerky movements with a considerable amount of dramatic arm and leg extensions into midair (salute), tone variable much of the time predominantly hypertonic. Moderately frantic activity or several bouts of frantic activity alternating with no or very mild activity, predominantly undifferentiated whole arm and leg movements.

8. Strongly hyperextended and/or hyperflexed postures alternating with occasionally completely flaccid postures. If movement, hyperextension alternating with sudden, abrupt changes and jerky adjustments; jerky movements with dramatic arm and leg extensions into midair (salute), at times completely flaccid tone alternating with hypertonicity, excessive, frantic or diffuse activity alternating with no activity at all; undifferentiated whole arm and leg movements.

9. Completely flaccid posture essentially without active adjustments, tone, or activity.

III. State System

Various configurations of behaviors encompassing eye movements, eye opening and facial expressions, gross body movements, respirations, and tonus aspects are used in specific temporal relationships to one another in order to determine at what level of arousal an infant is at a particular time. Reliably identifiable dynamic transformations of various behavioral configurations appear to correspond to varying states of availability and responsiveness. A spectrum of six observable states is defined. Based on the Brazelton Neonatal Behavioral

Assessment Scale (Brazelton, 1984), for each state level, three degrees of modulation are differentiated. States labeled as A states are poorly modulated, diffuse states; states labeled as B states are well defined, well modulated, and robust states. The AA notation describes respiratory pausing for more than 8 seconds at any states level.

Sleep States

State 1 Deep sleep

State 1A: Diffuse deep sleep with obligatory regular breathing or breathing in synchrony with only the respirator, eyes closed, no eye movements under closed lids; quiet facial expression; no spontaneous activity; typically poor color.

State 1B: Robust deep sleep with predominantly modulated regular breathing; eyes closed, no eye movements under closed lids, relaxed facial expression; no spontaneous activity except isolated startles.

State 2 Light sleep

State 2A: Diffuse light sleep with eyes closed, rapid eye movements observed under closed lids; low amplitude activity level with diffuse and disorganized movements; respirations irregular; many sucking and mouthing movements, whimpers, facial, body, and extremity twitchings, much grimacing; the impression of a diffuse state; color typically poor.

State 2B: Robust light sleep with eyes closed; rapid eye movements observed under closed lids; low activity level with movements and dampened startles; movements likely to be of lower amplitude and more monitored than in State 1; responsive to various internal stimuli with dampened startle; respirations more regular, mild sucking and mouthing movements off and on; one or two whimpers, as well as infrequent sighs or smiles.

Transitional States

State 3 Drowsy.

State 3A: Diffusely drowsy, semi-awake or semi-asleep; eyes open or closed, eyelids fluttering or blinking very exaggeratedly; if eyes open, a glassy veiled look; activity level variable, with or without interspersed, startles from time to time; diffuse movement; fussing and/or much discharge of vocalization, whimpers, facial grimacing, etc.

State 3B: Robustly drowsy, as above yet with little discharge of vocalization, whimpers, facial grimacing, etc.

Awake States

State 4 Quietly awake and/or alert.

State 4A: Diffusely awake. Two types of diffuse alertness are distinguished, 4AL and 4AH. L or H is marked instead of a check mark

State 4AL: Low keyed, lidded, diffuse awakeness; quiet, minimal motor activity, eyes half open or open with glazed, dull, or pained look, giving the impression of little energy; or focused yet strained alertness, appearing to look through, rather than at, an object or caregiver.

State 4AH: Hyper-alert; eyes wide open, giving the impression of panic, fear, or overwhelmedness; appearing to be hooked by the stimulus; apparent difficulty in modulating or breaking the intensity of the fixation to an object or the caregiver; apparent difficulty in turning the gaze away.

State 4B: Robustly alert with bright shiny eyes, animated facial expression; focusing attention on a source of stimulation or a person; processing information actively and with modulation; motor activity is at a minimum.

State 5 Actively awake and aroused.

State 5A: Diffusely and actively aroused; eyes may or may not be open; clearly awake and aroused, as indicated by motor arousal, tonus, and distressed facial expression, grimacing, or other signs of discomfort. Vocal fussing, if present, diffuse or strained.

State 5B: Robustly and actively aroused; eyes may or may not be open; infant clearly awake and aroused, with considerable, yet well defined, motor activity and/or clearly fussing without crying robustly.

State 6 Highly aroused, agitated, upset, and/or crying.

State 6A: Diffusely and highly aroused with intense upset, as indicated by intense grimace and cry face, yet cry sound very strained, weak, or absent; intensity of upset very high.

State 6B: Robustly and highly aroused with rhythmic, intense, lusty crying, vigorous in sound.

AA Removal from the state continuum.

AA: Should the infant move into a prolonged respiratory pause, e.g., beyond 8 seconds, AA should be marked, indicating that the infant has removed him or herself from the state continuum.

Behavioral indices of the state system assessed by observation are recorded as seqûence of states in the second row of the state box; the order of predominance of states, which is indicated in a separate notation, is entered for the entire observation in the bottom row of the state boxes. The overall scaled state scores for the observation before, during, and after caregiving, are entered in the respective top open box of the state system score sheet.

Scoring

1. The infant is always in well-defined states (1B, 2B, 3B, 4B, 5B, or 6B). If sleeping, esp. when not interacted with, the sleep or drowsy states are well modulated (1B, 2B, 3B). If fussing or crying, this is robust and well modulated (5B or 6B), and the infant is consolable and returns to alertness or sleep readily. When alert, the alert states are well modulated and robust (4B).

2. The infant comes into a modulated alert state (4B) for brief periods; the states the infant comes from or goes to are well-defined states of arousal or drowsiness (5B, 6B, or 3B) or the infant maintains a quite well-defined sleep state 1A with B, 2A with B, or 3A with B when not interacted with.

3. The infant may come into a diffusely alert state (4AL or 4AH) although there are also brief periods of modulated alertness (4B) with oscillations to modulated arousal (5B or 6B). When not interacted with, the infant may be in a diffuse sleep or drowsy state (1A, 2A, or 3A).

4. The infant comes into a diffusely alert state (4AL or 4AH), yet also shows the beginnings of modulated alertness (4B minimally). There may be oscillations to partially diffuse sleep or aroused states (3A with B, 5A and/or 6A with B). One or the other state bordering on the alert states (4) is a modulated state (B), at least at times.

5. The infant comes into an alert state, yet it is diffuse and/or disorganized (4AH or 4AL). The infant may show oscillations to largely diffuse sleep states (1A with some B; 2A with some B; 3A with some B), or to largely diffusely aroused states (5A or 6A with some B); or the infant is exclusively in largely diffusely aroused states (5A or 6A with some B) and alertness is not observed (4A or B).

6. The infant oscillates repeatedly between at least partially well-modulated sleep (1A/B, 2AB, 3AB) and aroused states (5A and B, 6A and B).

7. The infant has periodic, sudden brief shifts from diffuse sleep states (1A, 2A, 3A) to diffuse aroused states (5A and 6A), or he is in diffuse aroused states (5A or 6A) more or less continuously.

8. The infant moves almost exclusively between diffuse sleep states, interspersed with pauses (1A, 2A, 3A, AA), and shows very brief periods of more well-modulated sleep states (1B, 2B, 3B).

9. The infant moves only between diffuse sleep states (1A, 2A, and 3A); the infant may show prolonged respiratory pauses (1AA, 2AA, and 3AA) and needs facilitation to recover.

IV. Attentional/Interactive System

Behavioral indices of the attentional/interactive system are the degree of modulation of the infant's alert state, its robustness and availability, the duration of the infant's responsivity to animate and inanimate stimuli presented, and the modulation and differentiation with which the infant utilizes alertness to seek out and initiate interaction with various social and inanimate stimuli..

Scoring

1. Attention and responsivity are robust (4B) and of long duration; the infant actively selects the target of attention and shifts smoothly from one target to another at the infant's own initiative, freely inspecting the environment. The infant's face reflects bright-eyed, focused interest, the mouth may be softly shaped forwards, the cheeks and eyebrows softly raised, there may be an occasional coo or smile and/or subtle, cyclical facial adjustments of attentional interaction.

2. The infant's attention is of considerable duration, and almost all the time bright, focused, robust, and well-modulated (4B), and there may be an occasional episode of active environment inspection or target selection, with only minimal diffuseness (4AL or 4AH).

3. The infant's attention is of moderate duration and robustness, predominantly bright, focused, and well-modulated, directed and maintained by the stimulus, with only brief evidence of diffuseness (4AL or 4AH).

4. The infant's attention is of moderately to predominantly bright, focused, and well-modulated (4B), at other times it is either low keyed or hyper-alert (4AH or 4AL), or of relatively short duration.

5. The infant's attention is for moderate periods modulated and well organized (4B), yet at other times may also be diffusely low keyed (4AL) and/or hyper-alert (4AH).

6. The infant's attention is variable, the infant may show periods of hyper-alertness or low-keyed diffuseness (4AL) which are intermittently briefly modulated in focused attention (4B). There are brief episodes of modulated processing embedded in more diffuse attention.

7. The infant's attention is quite variable, shifting from hyper-alert or diffusely alert, possibly intermittent panicked facial expression or overly wide eyes (4AH) to unavailable with floating or rolling eyes and/or eye closed in rapid shifts (4AL). The duration is short, and there appears to be little modulation or control on the infant's part, or the infant is in diffusely lower-keyed or hyper-alert states throughout, without achieving modulation..

8. The infant's attention or alertness is only barely available for fleeting periods. Then the quality of attention is either diffuse or, although briefly focused, very transient.

9. Alertness and attention is not observed at all.

V. Self-Regulatory System

Behavioral indices of the self-regulatory system are reflected in the infant's use of varying autonomic, motoric, and/or state organizational strategies in order to maintain and/or return to a balanced, well-regulated interplay and equilibrium of the autonomic, motoric, and state systems, consisting either of solid sleep states or calm alert states.

Scoring

1. The infant is well modulated and well regulated throughout. The infant readily maintains a well-modulated alert state (4B) or a calm sleep state (2B, 1B), without losing regulatory balance. Should the infant cry, the cry is robust, and the infant is readily consoled and comes to calm alertness or sleep.

2. The infant maintains self-regulation successfully most of the time and/or returns to balance fairly easily and consistently. The regulation strategies are highly differentiated (sneezing, yawning, subtle attentional cycling, etc.).

3. The infant makes consistent efforts at maintaining self-regulation and at returning to balance. The infant generally is successful, although at times with some difficulty.

4. The infant makes repeated, prolonged, and differentiated efforts at maintaining self-regulation and at returning to balance. The infant repeatedly maintains self-regulation for moderate periods or returns to balance occasionally.

5. The infant makes repeated efforts at maintaining self-regulation and at returning to balance; some of the efforts are quite differentiated, and some are successful.

6. The infant makes several noticeable efforts at maintaining self-regulation and at returning to balance; they may be gross and/or minimally and transiently effective.

7. The infant makes efforts at maintaining self-regulation and at returning to balance, yet they are unsuccessful.

8. The infant does not show efforts at self-regulation at all. Although the infant responds to interactions and procedures, the infant appears completely at the mercy of the manipulations. The infant does not regain even partial balance.

9. No effort at behavioral self-regulation is noticeable; the infant is essentially not responding to manipulations, and self-regulation is not observed.

VI. Need For and Use of Caregiver Facilitation

Behavioral indices of the infant's need for and use of the caregiver's or interactor's facilitation are observed in the kind and degree of regulatory effort the infant exhibits and the degree of successful regulation when co-regulatory facilitation is forthcoming. Should co-regulatory facilitation not be forthcoming, although the infant is in obvious need for it, the degree of success of regulation is estimated, were facilitation offered.

Scoring

1. The infant consistently maintains a well regulated level of behavioral organization, and the caregiver/interactor may proceed with ease; the infant may actively seek out the caregiver/interactor for differentiated interaction and/or dialogue.

2. The infant appears to be occasionally in need of very mild facilitation such as occasional brief times out or adjustment of the interaction or brief containment, i.e., the interactor/caregiver may present a maneuver somewhat more delicately or slowly. When this is forthcoming, the infant is consistently well regulated.

3. The infant appears to be in need of some facilitation in order to maintain or regain balance. The facilitation needed may be mild, such as movement inhibition by occasional hand holding or by postural shifting, offering the infant to brace the feet against the crib or the caregiver, or providing some time out; or the infant might suck on the caregiver's or won finger or pacifier, maintaining this essentially on the infant's own accord.

4. The infant appears to be in need of a moderate degree of facilitation from the interactor/caregiver in order to maintain or regain balance. The facilitation needed may consist of motoric inhibition by containing or holding the infant, wrapping the infant in a blanket, containing the infant's hands or feet for moderate periods, or by repeated times out. If these are forthcoming, the infant appears to be well regulated.

5. The infant appears to be in need of a considerable degree of facilitation from the interactor/caregiver in order to maintain or regain balance. The facilitation needed consists of repeated, moderately long times out, motoric inhibition by hand holding, postural facilitation, and wrapping. If these are forthcoming, the infant appears to be well regulated.

6. The infant appears to be in need of quite a substantial degree of facilitation in order to maintain or regain balance. The facilitation needed may consist of repeated periods of considerable motoric inhibition and repeated times out or prolonged interactor/caregiver induced and facilitated sucking. If these are provided, the infant appears quite well regulated quite easily each time.

7. The infant appears to be in need of a substantial degree of facilitation from the interactor/caregiver in order to maintain or regain balance. The infant appears to need prolonged and repeated motoric inhibition and sucking or lengthy periods of time out, with or without sucking, which are expected to eventually free the infant's self-balance and maintenance for brief periods.

8. The infant appears to be in need of a very substantial degree of facilitation and/or containment from the interactor/caregiver. The facilitation needed appears to be complete motoric inhibition, and sucking and long resting periods, which are expected, nevertheless, to work only moderately well.

9. The infant appears to be in need of continuous, very carefully instituted and very considerable facilitation, such as prolonged complete motoric inhibition and containment with sucking and prolonged resting periods, which nevertheless work only barely; or the infant appears in need of being completely contained without any demand placed on the infant, and any interaction beyond containment appears inappropriate.

VII. Effectiveness of Caregiver Facilitation

Facilitation of caregiving and interaction provided encompasses consideration of the degree of effectiveness in the arrangement of the environmental circumstances of the caregiving interaction; the preparatory planning and subsequent implementation of the sequence of the subcomponents of the caregiving steps; and the transitions from step to step., Observed are also, where appropriate, the degree of anticipatory guidance and stage setting for parent and family as the primary co-regulators of the infant; the degree of co-regulation of the emotional and interactive competence of parents and the infant; the caregiver's attunedness to the infant's autonomic, motoric, and state regulatory efforts and strengths; the assurance of opportunities for the infant's and parents' experience of pleasure and pride in the course of the interaction; as well as the effective, implementation of the technical aspects of caregiving, and the cohesive and appropriate embedding of the technical aspects in the developmental interactive matrix of the caregiving dialogue. Evidence of sensitivity and effectiveness of facilitation provided is found in environmental cues as well as in the caregiver's body language, including posture, gestures, facial expression, and timing of movements, etc., in verbalizations and apparent affective availability

Examples of facilitation of the infant's individual competencies and self-regulatory efforts include hands-on containment, hand swaddling, flexor support, holding the infant, as well as supporting the parents' co-regulation opportunities effectively; the use of creative bedding; the offering of a pacifier or finger, appropriately timed for mouth satisfaction and regulation; social interactions carefully titrated to the infant's state changes; individually supportive timing and structuring of care; as well as attention to and support of self-regulation, including sleep organization beyond a 24-hour period.

Scoring

1. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is consistently individualized, sensitive and effective in their support of the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant as an individual and to the infant's family is consistently observable, expressed in the quality of body and hand movements, facial and vocal expression and the overall structuring of the caregiving situation.

2. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is almost all of the time individualized, and sensitive and effective in its support of the infant's and family's regulatory strengths and inferred developmental goals. Emotional attunedness to the infant as an individual and to the infant's family is almost consistently observable.

3. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is to a considerable degree individualized, and sensitive and effective in its support of the infant's and family's regulatory strengths and inferred developmental goals. Emotional attunedness to the infant and the infant's family is considerable.

4. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is to a moderate to considerable degree individualized, sensitive and effective in its support of the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant and the infant's family is moderate to considerable.

5. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is to a moderate degree individualized, sensitive and effective in its support of the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant and the infant's family is moderate.

6. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is to a less than moderate degree individualized, sensitive and effective in its support of the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant as an individual and to the infant's family may be observed at times.

7. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is to a minimal degree individualized, sensitive and effective in its support of

the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant as an individual and to the infant's family may be minimal.

8. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is barely individualized, sensitive or effective in its support of the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant as an individual and to the infant's family is barely noticeable.

9. Timing, preparation for, kind, sequence and flow of implementation of caregiving and/or interaction is not at all individualized, sensitive or effective in its support of the infant's and family's regulatory strengths and inferred goals. Emotional attunedness to the infant as an individual and to the infant's family is absent.

Literature Cited

Als H, Lester BM, Tronick E, Brazelton TB: Manual for the assessment of preterm Infants' behavior (APIB). In Fitzgerald HE, Lester BM, Yogman MW (eds.), *Theory and Research in Behavioral Pediatrics, Vol. 1.* New York: Plenum, 1982, 64-133.

Brazelton TB: *The Neonatal Behavioral Assessment Scale. Second Edition.* Clinics in Developmental Medicine, No. 88, Philadelphia, Lippincott, 1984.

ABSO Scores

Name _____ Date of Observation _____

Hospital/City _____ Gest. Age at Observation _____

Medical Record # _____ Age at Observation (days) _____

DOB _____ Observer(s) _____

Gest. Age at Birth _____ Scorer(s) _____

NIDCAP # _____ Location of Observation _____

Caregiver(s) Observed _____

Sequence of Caregiving Components _____

_____

_____

Duration of Observation (minutes.): Before _____

During _____

After _____

	Autonomic System	Motor System	State System	Attention/ Interaction System	Self-Regulatory System	Need for/ Use of Facilitation	Caregiver Facilitation
Before Caregiving							
During Caregiving							
After Caregiving							

Comments _____

_____

_____

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Data gathered by: _____

Date gathered: _____

NICU/SCN SITE COMPLEXITY INDEX VARIABLES

Site: (circle) BWH CHB BIH TUC CHO

Index Date: (circle) June 1991 January 1992 Other: _____

1. Number of square feet per bedside _____

2. Total number of licensed beds _____

3. Number of licensed Level III/ICU beds _____

4. Number of licensed Level II/intermediate/special care beds _____

5. Number of care rooms separated by walls with doors or door width openings _____

6. Total number of nursing staff full-time equivalents (FTE) _____

7. Total number of nursing staff on payroll _____

8. Average number of per diem and agency nurses per month _____

9. Number of different unit-based nursing roles within the NICU/SCN cost center _____

(Check if role exists at site)

Nursing Director, Hospital ____
Nursing Director, Women's and Infant Health (or equivalent) ____
Nurse Manager or Head Nurse for NICU/SCN ____
Assistant Head Nurse ____
Nurses in Charge ____
Assistant Nurses ____
Discharge Nurses ____
Transport Nurses ____
ECMO Nurses ____
Neonatal Nurse Practitioners ____
Clinical Nurse Specialists ____
Licensed Practical Nurses ____
Staff Nurses ____
Nurse Technicians and/or Nursing Aides (or equivalent) ____
Existence of Nursing Clinical Career Ladder Levels ____

10. Number of different roles (non-NICU cost center based) with specified time commitment providing staff support, (e.g. Psychology, Clinical Nurse Specialist paid by Human Health Division and assigned to NICU for staff support for 10 hours ; or staff educator paid by Education Department; list each of the roles below then total) _____

_____
_____
_____

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11. Average number of volunteers per month involved in patient care, family support, and/or comfort provision (cuddlers, etc.) _____

12. Number of medical care deliverers (MDs and NNPs) per month _____
(including average number of staff members covering nighttime and weekends)

13. Number of other staff in the unit on a regular basis _____
Enter individual counts per category, then total.

Secretaries	____
Clerks	____
RTs	____
Social Workers	____
PTs	____
OTs	____
Nutritionists	____
Others: _____	____
_____	____
_____	____
_____	____

14. Number of levels of medical education represented in unit _____
Check if level exists at site, then total.

Chief	____
Attendings	____
Fellows	____
Residents	____
Interns	____
Medical Students	____
Others: _____	____
_____	____
_____	____
_____	____

15. Number of medical services overseeing the day-to-day care in the NICU _____
Check if service exists at site, then total.

In-House Neonatology	____
Cardiac Surgery	____
General Surgery	____
ECMO Service	____
Health Plan with Neonatologist in NICU	____
Private and/or Health Plan Pediatricians	____
Others: _____	____
_____	____
_____	____
_____	____

16. Number of different attendings rotating through the unit per year _____
From rotation schedule

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Date gathered: _____

FAMILY COMPLEXITY INDEX VARIABLES

Site: (circle) BWH CHB BIH TUC CHO

Index Date: (circle) June 1991 January 1992 Other: _____

1. Socioeconomic Status (SES) _____
   % of study families in SES IV and V

2. Ethnicity _____
   % of study families of U.S. minority (non-caucasion) background

3. Ethnicity and SES _____
   % of study families of U.S. minority (non-caucasion) background AND in SES IV and V

4. Family Constellation _____
   % of study families without stable two-parent constellation (on FL1, single parents)

5. Parental Age _____
   % of study families with maternal age 18 and below

6. Drug/Alcohol Use _____
   % of study families with history of cocaine and/or other significant drug use (include use of any illegal drug during pregnancy, as well as report of more than 5 alcoholic drinks during pregnancy)

7. Nicotine Use _____
   % of study families with history of nicotine use

8. Parity _____
   % of families with first-born infants OR with parity > 3 (including the study child!)

9. Life Event Scale _____
   Mean score on the Life Events Scale

10. Maternal Social Support Index _____
    Mean score on the MSSI

11. Parental Stress Index _____
    % of study families with PSI Total Score in the clinical range (as defined in the PSI manual; <15th percentile or >80th percentile)

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Data gathered by: _____

Date gathered: _____

DEVELOPMENTAL CARE SUPPORT INDEX VARIABLES

Site: (circle) BWH CHB BIH TUC CHO

Index Date: (circle) June 1991 January 1992 Other: _____

1. Percentage of NIDCAP introduced nurses _____
   (# of FTE of NIDCAP introduced nurses / # of FTE nurse positions: ____/ ____)
2. Percentage of NIDCAP reliable nurses _____
   (# of FTE of NIDCAP reliable nurses / # of FTE nurse positions: ____/ ____)
3. Number of NIDCAP introduced other staff _____
4. Number of NIDCAP reliable other staff _____
5. Number of NIDCAP introduced leadership staff (list titles below) _____

   _____
   _____
   _____
   _____

6. Number of NIDCAP reliable leadership staff (list titles below) _____

   _____
   _____
   _____
   _____

7. Number of hours of developmental care nursing orientation per nurse _____
8. Number of hours of developmental care physician orientation and/or education per physician _____
9. Number of unit cost center paid hours of staff person responsible for developmental care implementation _____
10. Number of hours paid or time freed up for NIDCAP training and practice for staff beyond orientation per staff member _____

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Data for items 11 - 16 will be supplied by L. Gilkerson from site visit notes.

11. Staff perception of quality and effectiveness of Developmental Specialist at site (as rated by project nurses)
1 = poor, ineffective; 3 = moderately effective; 5 = highly effective

12. Staff perception of quality and effectiveness of Developmental Nurse Liaison at site (as rated by Developmental Specialist at site) _____
1 = poor, ineffective; 3 = moderately effective; 5 = highly effective

13. Quality and effectiveness of Developmental Specialist at site _____
(as rated by Site PI, NCRI PI, NCRI Co-Director, and Senior Developmental Specialist)
Mean of 4 scores: 1 - 5

14. Quality and effectiveness of Nurse Liaison at site _____
(as rated by Site PI, NCRI PI, NCRI Co-Director, and Senior Developmental Specialist)
Mean of 4 scores: 1 - 5

15. Developmental leadership skill, commitment and effectiveness of Medical Director and of Nursing Director or Nurse Manager _____
(as rated by Developmental Specialist, Developmental Nurse Liaison, Site PI, NCRI PI, NCRI Co-Director, and Senior Developmental Specialist)
Mean of two means (Medical Director and Nurse Manager) with six scores each: 1 - 5.

16. Leadership commitment as evidenced in supporting a NIDCAP training center. _____
1 = yes; 2 = no

Continue coding items 17 - 19.

17. Number of organizational structures to support developmental care instituted in the course of the project _____
(Check off on list and count total)

Developmental Committee	____
Developmental Rounds	____
Sibling Corner	____
Intern and Resident Developmental Training	____
Formalized Developmental Consultation	____
Developmental Work Groups	____
Formalized Support Toward Kangaroo Care	____
Parent Advisory Council	____
Parent Focus Groups	____
Parent Support Group	____
Antenatal Parent Support Program	____
Professionally Led Staff Support	____
Development or Revision of Developmentally Focused Educational Materials (e.g. parent booklets, family and staff education materials, etc.)	____
Others: _____	____
_____	____
_____	____
_____	____

18. Number of developmentally supportive materials introduced unit-wide in the course of the project _____
(Check off on list and count total)

Buntings; nests	____
Sheepskin	____
Isolette covers	____
Hammocks	____
Bili blankets	____
Kangaroo-care chairs	____
Others: _____	____
_____	____
_____	____
_____	____

19. Number of changes of physical environment aspects introduced in the course of the project _____
(Check off on list and count total)

Carpeting	____
Lighting changes	____
Home-like decor	____
Sitting corners	____
Parent spaces	____
Parent storage spaces	____
Parent telephones	____
Others: _____	____
_____	____
_____	____
_____	____